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Origins of Religiousness: The Role of Natural Disasters

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Abstract

Across 800 regions of the World, this research shows that people are more religious when living in regions that are more frequently razed by natural disasters. This is in line with psychological theory stressing that religious people tend to cope with adverse life events by seeking comfort in their religion or searching for a reason for the event; for instance that the event was an act of God. This is termed religious coping. Natural disasters are a source for adverse life events, and thus one way to interpret my findings is by way of religious coping. The results are robust to various measures of religiousness, and to inclusion of country-fixed effects, income, education, demographics, religious denominations, and other climatic and geographic features. The results hold within Christianity, Islam and Buddhism, and across continents. To eliminate bias from omitted variables and selection (perhaps religious people are less likely to move out of disaster areas as they see the disaster as an act of God), I further show that second generation immigrants whose mothers descend from natural disaster areas, are more religious than their counterparts with ancestors from calmer areas. Why should economists care? Evidence suggests that religiousness influences economic outcomes (e.g., McCleary & Barro (2003), Iannaccone (1998)).

1 Introduction

Major floodings hit the American Midwest along the Mississippi and Missouri rivers in 1993. The floodings were among the most costly and devastating that ever occurred in the United States. When asked whether they believed the flooding disasters were an indication of God's judgement upon the people of the United States for their sinful ways, 18 percent of the surveyed Americans answered in the affirmative in a Gallup survey.[1] Apparently, humans have an evolved tendency to search for reasons, and thus to interpret natural phenomena as happening for a reason rather than by chance alone.[2] According to psychologists this is a way of coping with stress.

More generally, according to psychological theories of religious coping, religious people tend to cope with adverse life events by 1) turning to their religion for relief and stength, 2) engaging in religious acticities such as going to church, and 3) searching for a reason for the event; for instance that the event was an act of God as with the flooding example.[3] The two former are termed the Uncertainty hypothesis,[4] while the latter has been termed the supernatural punishment hypothesis or simply Acts of God.[5] The direct testable implication is that people become more religious when faced with adverse life events, which has received some empirical support at the micro level.[6] The main econometric concern in these studies is that adverse life events such as cancer, other diseases, death within close family, accidents etc are endogenous to the individual's lifestyle, which might independently correlate with their degree of religiousness.

By using natural disasters as an exogenous source of adverse events, this study solves the endogeneity concerns. And further, since natural disasters hit society at large, but are felt more in some societies than others, I am able to extend the testing from individuals to society comparisons. Specifically, I test the hypothesis that people living in societies that are more frequently hit by adverse life events (in the form of natural disasters) are more religious. The idea is that the uncertainty created by natural disasters increases the religiousness of the society

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[1]Cited by Steinberg (2006).

[2]E.g., Guthrie (1995).

[3]E.g., Cohen & Wills (1985), Park *et al.* (1990).

[4]E.g., Williams *et al.* (1991). Also termed the buffering hypothesis or religious coping.

[5]Steinberg (2006), Johnson (2005).

[6]E.g., Koenig *et al.* (1988) and McCrae (1984).

as a whole, potentially spreading a culture of religiousness to generations that were not even hit by natural disasters.

I find support for this across 800 subnational regions of the World using various measures of religiousness from the pooled World Values Survey and European Values Study. I measure disaster frequency as the distance to zones of earthquakes, volcano eruptions, and tropical storms.[7] I find that regions located closer to zones of natural disasters tend to be more religious. The result is robust to including country-fixed effects, income, education, demographics, religious denominations, climatic and geographic factors, and robust to various estimation techniques: OLS, ordered logit, and probit estimation. I perform the analysis across individuals as well as across regions.

Further, the impact of natural disasters is similar within Christianity, Islam, and Buddhism and within the six continents. The theory does not seem to hold within Hinduism, which takes up only 5.5% of the sample, though. This insight is also useful to the micro literature on religious coping, since much of what is know about religious coping has evolved from studies based largely on Christian samples. In my larger sample including the entire World, I am able to test in detail whether some religions react to the stress caused by natural disasters.

Still, I might not have controlled for all relevant confounders, and the issue of selection might bias the results; perhaps atheists choose to move away from disaster areas to a larger extent than religious people, who see the disasters as consequences of their own actions, thus making moving less of a solution. I account for the concern of selection and the impact of confounders in peoples' current environment by using the epidemiological approach by Fernandez (2011). Using information from the European Social Survey on second generation immigrants in Europe, I find that second generation immigrants whose mother descended from disaster prone areas, are more likely to pray regularly and to regard themselves as a religious person.

Consistently within both studies (across subnational regions and across second generation immigrants), I find that increased disaster-frequency increases religiousness in the sense of believing, but only to a lesser extent in terms of going to church. This is in line with a study of

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[7]There are other ways one could go about measuring the impact of disaster frequency. One is to measure the impact on religiousness of one particular disaster. I am interested in explaining differences in religiousness across the entire globe, though, and not idiosyncratic shocks. Another approach is to use losses from natural disasters, which is highly endogenous to economic development and therefore not useful here.

100 older adults by Koenig *et al.* (1988), who found that respondents tend to cope with adverse life events through faith in God, prayer, and help from God; and not through church-related activities.

I interpret the impact of natural disasters on religiousness as a consequence of the two outlined channels from psychological theories of religion: Some religious people might cope with the stress caused by natural disasters by turning to their religion, while others might see natural disasters as a sign from God, thus confirming them in their beliefs and inducing them to increase prayer in order to prevent future reprisals from God. The finding that immigrants who are not themselves hit by natural disasters, are influenced by the disaster frequency experienced by their mothers point to a broader, more general impact of disasters on cultural values for religiousness.

This research contributes to our understanding of the origins of differences in religiousness across societies.[8] The existing literature struggles with endogeneity issues, and the present study contributes by identifying an exogenous source of religiousness differences. My findings can further be interpreted as one explanation to the fact that religiousness has not declined greatly with increased wealth and knowledge as the modernization hypothesis otherwise suggests. In a survey of the literature on the economics of religion, Iannaccone (1998) notes that numerous analyses of cross-sectional data show that neither religious belief nor religious activity tends to decline with income, and that most rates tend to increase with education. Indeed, if an exogenous deep determinant of religiousness exists, which still is at play today, this might help understand the persistence of religiousness.[9] One such deep determinant might

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[8]Equivalently; since all societies were religious if we go far enough back into history (see e.g., Brown (1991) and Murdock (1965)), this research explains one reason why secularization hit some societies to a larger extent than others.

[9]Related to this, a literature within evolutionary psychology examines why a biologically costly trait as religiousness survived to this day. Here, the paradox is why evolution didn't choose against religiousness. Some evolutionary psychologists argue that religion must provide, or in the ancestral past must have provided, countervailing adaptive benefits (e.g. Bulbulia (2004)). Perhaps the most influential of such proposals is that religion confers a selective advantage by securing and promoting cooperative behaviour within a group. The argument goes as follows. Cooperation is difficult to achieve due to free rider problems. The existence of a credible threat of punishment of those who deviate can however uphold cooperation nonetheless. Again there is an incentive to free-ride on others' punishment costs, which thus becomes a second-order public good. If some supernatural agent, God for instance, is believed to punish those who act in a non-cooperative way, this reduces the cost of punishment and enables sustained cooperation. According to this theory, religiousness does not die out over time despite its evolutionary costs as cooperation is cheaper in religious societies, increasing

be frequency of natural disasters.

As economists, the origin of differences in religious beliefs is particularly interesting in light og the suggestive evidence of a lasting impact of religion on economic outcomes. Weber (1905) suggested in his famous argument that the Protestant ethic with a focus on hard work and thrift, spurred investment and growth. Andersen *et al.* (2011) find some support for this, albeit showing that these particular values have a pre-Reformation origin. Weber's hypothesis concerns the contents of religious beliefs, while the present study is about the degree of believing. Related to this, McCleary & Barro (2006) find that beliefs in heaven and hell (what they term believing) tend to increase GDP per capita growth across countries, while going to church (termed belonging) has a significantly negative influence. This is further partly supported in a study across rural households in Tibet by Tu *et al.* (2011), who show that intensity of religious beliefs about the afterlife has a positive bearing on income, while time and money spent in the temple has am inverted U-shaped relation with income. Across individuals in the World Values Survey, Guiso *et al.* (2003) find that religious beliefs are associated with what they term 'good' economic attitudes. In particular, religious people trust others more, trust the government and the legal system more, are less willing to break the law, and are more likely to believe that market outcomes are fair. Iannaccone (1998) surveys the literature on religion and growth and concludes that religiousness has not reduced over time and seems to affect a range of behavioral outcomes. Kimball *et al.* (2009) provide a survey of additional economic correlates with religiousness and religious affiliation, including education, mate choice, cohabitation, fertility, female labour force participation, employment and working hours, intergenerational transfers, abuse of various substances, physical and mental health.

While most of the micro-literature attempting to test the theory that people become religious when faced with adverse life events, suffers from endogeneity problems, Norenzayan & Hansen (2006) account for this using an experiment. They perform a controlled experiment of 28 students, showing that the subjects that were primed with thoughts of death were more likely to believe in God. This was interpreted in relation to the Uncertainty hypothesis; the subjects cope with the thoughts of death by turning to God.

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chances of survival. For empirical support for this, see e.g., Bering *et al.* (2005), Bering (2006), and Shariff & Norenzayan (2007).

I am not the first to study the link between disasters and religiousness. After the September 11 attack, Schuster *et al.* (2001) found that 90% of the surveyed Americans reported that they coped with their distress by turning to their religion. The impact was self-reported, though. Penick (1981) investigated reactions to the massive earthquakes in 1811 and early 1812 with epicenter in Missouri, USA. He notes that membership in the Methodist church increased by 50% from 30,741 in 1811 to 45,983 in 1812 in midwestern and southern states, where the quakes were felt most forcefully, compared to an increase of only 1% in the rest of the United States. Steinberg (2006) reports that the earthquakes were interpreted by many as a sign of God's power, but apparently also seem to have inspired those who had somehow lost their faith in God to return to the fold. The present study tests whether these examples extend to societal comparisons and thus whether they leave an imprint on the culture of religiousness across societies.

More generally, the current study relates to research on the impact of geographic uncertainty on religiousness. Ager & Ciccone (2012) show that American counties, relying on agriculture, faced with higher rainfall variability saw higher rates of church membership in 1900. The interpretation is that the church acts as a type of insurance against risk, which should be more valuable in communities facing greater risk, making membership in religious organizations more attractive in high-risk environments. Snarey (1996) argues that societies located in areas under environmental conditions of exreme scarcity are more likely to believe in High Gods that legitimize moral codes designed to protect natural resources. Snarey shows empirically that societies located in areas with less rain are more likely to believe that High Gods influence their lives, inducing them to engage in harsher, more costly rituals. I find some support for the hypothesis by Ager & Ciccone (2012), but not for Snarey (1996), and neither change my results.

A more technical contribution of this study is that once a causal relation from natural disasters to religiousness has been established, I might be able to exploit this exogenous variation in religiousness in order to solve for endogeneity issues when attempting to identify the causal impact of religiousness on economic outcomes.

The paper is structured as follows. Section 2 reviews the psychological literature on adverse

events and religiousness. Section 3 introduces the data and presents the empirical results for individuals across subnational regions of the World and across second generation immigrants in Europe. Section 4 concludes.

2 Psychological theory relating to disasters and religiousness

Coping is generally viewed as a process through which individuals try to understand and deal with significant personal and situational demands in their lives (Lazarus & Folkman (1984)). Psychology of religion specializes in the part of coping, which relates to religion, and according to this literature, religious coping can be divided into three groups.[10] That is, religious people in crisis tend to cope by 1) obtaining a personal closeness with God, a sense of meaning and purpose in life, 2) engaging in religious coping activities, which are typically attempts to be less sinful and participation in church groups, and 3) searching for an explanation for the event; for example, tragedies can be evaluated as part of God's plan, a punishment from God, or uninted by God (e.g., Cook & Wimberley (1983)).[11] I investigate these strategies further below, where I refer to the two former as the Uncertainty hypothesis and the latter as the supernatural punishment hypothesis, or simply acts of God.

2.1 Acts of God hypothesis

Apparently, humans have an evolved tendency to constantly search for reasons, and thus to interpret natural phenomena as happening for a reason rather than by chance alone (Guthrie (1995), Bering (2002)). From there, it seems a small step to assign the cause to some supernatural agency (Johnson (2005)). Certainly, this belief was the rule rather than the exception before the Enlightenment. Hall (1990) describes the World before Enlightenment as a world where nothing happened at random. He called it a world by "radical contingency" and stressed

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[10]E.g., Pargament (2001).

[11]The examples are taken from Pargament (2001), who gathered the information through interviews with church and synagogue members, personal accounts of religious coping and a review of the literature.

that events such as earthquakes and floods always carried a larger, deeper meaning as manifestations of God's will.

For the Maya and Inca, Hultkrantz (1979) reports that "diseases were supposed to derive from crimes in the past - above all, theft, murder, adultery, and false testimony." Van De Wetering (1982) examined sermons written after the 1727 and 1755 New England earthquakes, felt over 300,000 square miles. All the texts agreed that "moral imbalance in human behavior" had caused the ground to shake. For these ministers, Van De Wetering (1982) concludes, "earthquakes, especially tragic ones, were not merely luckless occasions for the chance sufferer; they were deeply meaningful punishments and conspicuous warnings".

The 1993 Mississippi floodings example illustrates that natural disasters are still believed to be a punishment from God by some. Further, Taylor (1983)'s study of cancer victims, some victims interpreted the cancer as a challenge, or something from God designed to strengthen their faith; other victims perceived it as a threat.[12]

2.2   The Uncertainty hypothesis

The Uncertainty hypothesis has its roots in the following case study. Bronislaw Malinowski, one of the fathers of ethnography, lived with the Trobriand islanders of New Guinea for several years around 1910 to study their culture. Rituals were crucial in the lives of all islanders, who were convinced that their agricultural yields benefitted just as much from rituals and magic as they did from hard work and knowledge. Malinowski observed a variation in the use of rituals, though. When going fishing inside the calm lagoon, the Trobriand islanders relied entirely on their fishing skills. But when fishing outside the lagoon in the dangerous, deep ocean, they engaged in various rituals. Malinowski interpretted the rituals as helping the islanders to cope with the stress involved with the unforeseen dangers of the open sea. Malinowski's theory was later termed the buffering or Uncertainty hypothesis, which refers to the tendency for religious people to use their religion when faced with unforeseen adverse life events (e.g., Cohen & Wills

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[12] Another present-day example is a poll made on debate.org (a public debating website), where 23% of the members answered in the affirmative to the question "Are natural disasters acts of God?" http://www.debate.org/opinions/are-natural-disasters-acts-of-god

$(1985))$.[13]

When faced with times of crisis, religious people may choose to turn to their religion (e.g., Fichter (1981)). Religion might provide meaning, a sense of mastery, and self-esteem through one's relationship with a benevolent and omnipotent God. Further, Park *et al.* (1990) anticipated that religiousness would serve as a life stress buffer primarily for uncontrollable negative events.[14] Malinowski himself suggested a link between natural disasters and religiousness. He writes that (Malinowski (1948), p. 28) in the mind of the indigenous Trobriand islander, *"... certainly various kinds of disaster, blight, unseasonable droughts rains, bush-pigs and locusts, would destroy the unhallowed garden made without magic."* and further: *"He [the indigenous] knows as well as you do that there are natural conditions and causes, and by his observations he knows also that he is able to control these natural forces by mental and physcial effort."*

The Uncertainty hypothesis enjoys some empirical support. Koenig *et al.* (1988) asked a random sample of 100 older adults to describe the coping strategies they used to deal with three stressful events. Religious coping behaviors were most popular, cited by 45% of the sample. The most frequently mentioned coping strategies were trust and faith in God, prayer, and help and strength from God. Social church-related activities were less commonly noted. McCrae (1984) asked a community sample of 255 men and women to check the coping mechanisms they used to deal with a previously reported stressful event. The use of faith was one of the most common coping mechanisms reported by 75 % of the sample dealing with a loss and 72% of the sample dealing with a threatening event.

The stressful events that hit people in these studies are likely to be endogenous, though. Instead, controlled experiments show that people (and pigeons) react with rituals and superstition to uncertainty. Perhaps the first study to test the hypothesis was Skinner (1948), who found that pigeons who were subjected to an unpredictable feeding schedule developed super-

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[13]Also termed the coping hypothesis (e.g., Cohen & Wills (1985)). Steadman & Palmer (1995) argue that the fishermen's rituals is perhaps not due to fear, but might be a signalling of willingness to cooperate. By engaging in the rituals, the fishermen signalled that they were part of the same group and could thus be trusted. This improved the fitness of religious relative to non-religious people, explaining their continued existence.

[14]Both Fichter (1981) and Park *et al.* (1990) distinguish between extrinsic and intrinsic religiousness. Individuals belonging to the former use religion instrumentally to achieve other, more ultimate ends, while individuals engaging in intrinsic religiousness find their master motive in religion, and religion thus serves as the framework within which they live their lives (Allport & Ross (1967)). The hypothesis by Fichter (1981) and Park *et al.* (1990) relates to intrinsic religiousness.

stitious ritual behavior. Since Skinner's pioneering work, various studies have documented how children and adults in analogous experimental conditions quickly generate novel superstitious practices (e.g., Ono (1987)).[15] Norenzayan & Hansen (2006) show in controlled experiments that priming subjects with thoughts of death increases supernatural belief. The study comprised 28 undergraduate students from University of Michigan. Participants were randomly assigned to two conditions; mortality salience (MS) and a control group. The MS group was assigned to "write a paragraph about what will happen to you when you die." The control group were assigned to e.g., "write a paragraph about favorite foods that you have enjoyed eating." In a following questionnaire, the MS group had stronger beliefs in God and noted themselves as being more religious than the control group.

3 Empirical analysis

I measure religiousness using the pooled World Values Survey / European Values Study (WVS/EVS), which provides information on various dimensions of religiousness such as belief in God, Heaven, Hell, and afterlife. The pooled WVS/EVS provides information on the subnational region $r = 1, ..., 800$ in which the responding individual is interviewed, which I use to match with geographic data on natural disasters.

In order to test whether individuals are more religiousness when living in areas hit more frequently by natural disasters, I estimate equations of the form:

$$religiousness_{cri} = \alpha + \beta disasters_{cr} + X'_{cr}\eta + W'_{cri}\delta + I'_c\gamma + \varepsilon_{cri} \qquad (1)$$

where c refers to countries, r denotes subnational regions, and i refers to individuals surveyed in the pooled WVS/EVS.[16] β is the impact of natural disaster frequency on religiousness. $religiousness_{icr}$ is the religiousness of individual i living in region r located in country c.

I_c is a vector of country dummies eliminating variation from nationwide unobserved factors such as institutions or culture. X_{cr} is a vector of subnational regional level controls, including

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[15]See Sosis (2008) for an overview.

[16]I use the appropriate weights provided by the pooled WVS/EVS to account for over- and undersampling.

geography, population density etc. W_{cri} is a vector of individual-level controls such as income, age, sex, year of interview, and education.

In the main analysis, I estimate equation (1) by OLS. However, some of the religiousness measures are dummy variables and some are ordered categorical variables, and I thus supplement with probit and ordered logit estimation in the Appendix, confirming the OLS results.

The dependent variable varies at a higher level of disaggregation than the explanatory variable, which means that I face a potential problem of spatially correlated standard errors, which will bias the estimated standard errors. I account for this in two ways. In the main analysis, I cluster the standard errors at the subnational region level, which Wooldridge (2002) recommends when the number of clusters is large. This analysis includes between 400-800 clusters, which I consider as many.

Another way to account for the spatial dependence in the standard errors is to aggregate the individual-level variables up to the regional level (e.g., Angrist & Pischke (2008)). Hence for robustness, I provide Appendix tables, where I estimate equations of the form:

$$religiousness_{cr} = \alpha + \beta disasters_{cr} + X'_{cr}\eta + W'_{cr}\delta + I'_c\gamma + \varepsilon_{cr} \tag{2}$$

where $religiousness_{cr} = \frac{1}{N_r}\sum_{i=1}^{N_r}(weight_i \cdot religiousness_{icr})$ is the share of religious individuals in region r. N_r is the number of respondents in region r and $weight_i$ is the weights provided by the pooled WVS/EVS to account for over- and undersampling.

Religiousness might be influenced differently by natural disasters within different religious denominations, which I test by estimating equations of the form:

$$religiousness_{cri} = \alpha + \sum_{g=1}^{5}\beta_g disasters_{cr} \cdot I_g + X'_{cr}\eta + W'_{cri}\delta + I'_c\gamma + I'_g\lambda + \varepsilon_{cri} \tag{3}$$

where I_g are dummy variables for five groups of religion: Christianity, Islam, Buddhism, Hinduism and Other religions. β_g is the impact of disasters within religion g. For robustness, I estimate a similar set of equations, where I_g indicates continents, allowing the impact of disasters to differ between continents.

Still, a cause for concern is whether some potentially important factors are left out. Another

is whether the estimate of β is biased by the potential tendency for atheists to migrate out of natural disaster areas to a larger extent than religious people. The rationale would be that religious people see the disasters as a consequence of their own actions (Act of God), which will then not improve by reallocating. To account for this, the second part of the empirical analysis relies on data for second generation immigrants, where β will be estimated from the following equation:

$$religiousness_{cja} = \alpha + \beta disasters_{aj} + X'_{cj}\eta + W'_a\delta + V'_{aj}\lambda + I'_c\gamma + \varepsilon_{cja} \tag{4}$$

where j refers to a second generation immigrant living currently in country c in which he/she is also born, and whose parents migrated from country a. I_c is a vector of dummies wiping out country-wide effects of the immigrant-country (including disaster frequency). Now, β is the impact of natural disaster frequency in person j's country of origin on person j's religiousness. The method is called the epidemiological approach and relies on the assumption that cultural values are transferred across generations.[17] The estimate of β now does not include influences from factors in the immigrant's current environment, for instance institutions and culture. Perhaps more importantly, disaster frequency in the immigrant's country of residence is removed, and hence β is not biased by selection.

X_{cj} is a vector of immigrant-level controls. W_a are socio-economic and geographic factors in the immigrant's country of origin, which might correlate with disaster frequency. V_{aj} is a vector of socio-economic characteristics of the immigrant's mother and father.

3.1 Data on religiousness

The data on religiousness used for the cross-individual regressions of equation (1) and the cross-regional estimation of equation (3) is the pooled World Values Survey (WVS) and European Values Study (EVS) for 6 waves carried out in the period 1989-2009.[18] This dataset includes information from interviews of 320,689 persons residing in 90 countries. For 281,899 of these, I have information on which subnational region the interview was conducted in. I was able to

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[17]See Fernandez (2011) for a handbook chapter on the epidemiological approach.
[18]Available online at http://www.worldvaluessurvey.org and http://www.europeanvaluesstudy.eu.

match 229,183 individuals with a shapefile for first-level administrative borders necessary to match with the data on natural disasters. This leaves me with a dataset of 229,183 individuals living in 912 regions in 90 countries.

The individuals were asked a multitude of questions about cultural values, including their religious beliefs. To tie my hands in terms of choosing which religiousness measure to use, I follow Inglehart & Norris (2003), the fathers of the World Values Survey, who use six indicators from the pooled WVS/EVS to construct a Strength of Religiousity Scale. All indicators are increasing in the degree of religiousness. The six indicators are (when nothing else is indicated, these are dummy variables with 1="yes", 0="no"): (1) How important is God in your life? (0="not at all important",..., 10="very important"), (2) Do you get comfort and strength from religion?, (3) Do you believe in God?, (4) Are you a religious person? (1="convinced atheist", 2="not a religious person", 3="religious person"), (5) Do you believe in life after death?, and (6) How often do you attend religious services? (1="Never, practically never", ..., 7="More than once a week").

Three of the six measures are ordered categorical variables, which Inglehart & Norris (2003) reshape into dummy variables in order to calculate the share of a country's population that is religious. I replicate this for the cross-regional analysis, using the cutoff values from Inglehart & Norris (2003) to get a measure of the fraction of the population in a region that are religious (Appendix B). However, when the analysis is performed across individuals (and no shares have to be calculated), I do not have to throw away information by constructing dummy variables. Instead, I rescale them into measures between 0 and 1 to make the parameters comparable to the remaining religiousness measures (the results are robust to using dummy variables instead). Following Inglehart & Norris (2003), I use factor analysis to average them together into one measure. I also include the six religiousness measures one at a time together with six additional measures of religiousness from the literature. The remaining six measures are (when nothing else is indicated, they are dummy variables with 1="yes", 0="no"): (7) Do you believe in Sin?, (8) Do you believe in Hell?, (9) Do you believe in Heaven?, (10) Do you believe in the Devil?, (11) Do you believe in a soul?, and (12) Do you take moments of prayer/meditation? Note that the latter measure might not capture only religiousness, but also whether non-religious

individuals meditate. The 12 religiousness measures are depicted in Table 1. For instance, we see that 87% of the respondents believe in God, 64.2% believe in life after death etc.

Table 1. Summary statistics of the 12 religiousness measures

Measure	N	Mean	Measure	N	Mean
Importance of God[a]	221,001	.728	Believe in sin	100,250	.692
Comfort	143,702	.743	Believe in Hell	138,292	.548
Believe in God	147,850	.872	Believe in Heaven	139,392	.666
Religious Person[a]	215,366	.834	Believe in the Devil	61,043	.496
Life after death	136,668	.642	Believe in a soul	106,770	.835
Religious services[a]	218,577	.503	Pray	135,581	.730

Notes. Summary statistics of the 12 religiousness measures.
All variables, except those marked with an [a], are indicator variables.

To estimate the cross-immigrant equation (4), I rely on data from the European Social Survey (ESS), which includes three questions on religiousness:[19] (1) How often do you pray? (1="Never", ..., 7="Every day"), (2) How religious are you? (1="Not at all religious", ..., 10="Very religious"), and (3) How often do you attend religious services? (1="Never", ..., 6="Weekly or more often").[20] I rescale the variables to measures between 0 and 1. I restrict the sample to include only persons born in the particular country, but whose mother was born in a different country.[21] This leaves me with 6,101 individuals with mothers migrating from 151 different countries.

3.2 Data on natural disasters

As the purpose of the analysis is to test the long-term impact on one's beliefs from living in an area hit by natural disasters, I am not interested in the impact from one particular disaster,

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[19] The ESS is available online at http://www.europeansocialsurvey.org/.

[20] Religious services was originally a variable running from 1="Never" to 7="Every day". I recoded 7 to 6="Weekly or more often" to make the results comparable to the cross-individuals analysis. The results are unchanged if using the original variable.

[21] The literature on the epidemiological approach stresses that cultural influences come mainly from the mother.

but rather in identifying areas that are more or less frequently hit by natural disasters.[22] The "World Map of Natural Hazards", published by the Geoscience Research Group at Munich Reinsurance Company (Munich Re), depicts exactly this. It shows natural disaster zones based on the probability of occurrence of earthquakes, volcano eruptions and tropical storms at various intensity levels across the globe. The zones are divided into 5 categories each, depending on the severity of the particular natural hazard. The measure of earthquake zones includes numerous parameters such as historical earthquake reports, ground acceleration, duration of an earthquake, and subsoil effects.[23] The tropical storm intensity zones are based on the probability of occurrence of storms falling within five wind speed categories of the Saffir-Simpson Hurricane Scale.[24] The volcano intensity zones shows the density of volcanic eruptions based on the explosivity index for each eruption and the time period of the eruption. Eruption information is spread to 100 km beyond point source to indicate areas that could be affected by volcanic emissions or ground shaking. The source of the data is worldwide historical volcanic eruptions occurring within the last 10,000 years (to 2002) from Siebert & Simkin (2002).[25] The original World Map of Natural Hazards from MunichRe is replicated in Appendix Figure A1 and the individual components of the disaster measure are described in more detail in Appendix Table A1.

I extracted the highest-intensity zones for each disaster type, the result of which is depicted in Figure 1 below. Using ArcGIS software, I then calculated the variable $disasters$ as measuring the geodesic distance from the centroid of unit i (subnational region r or country c) to the closest zone of earthquakes, volcanoes or tropical storms. With this definition, I expect that $\beta < 0$, meaning that the further the unit is located away from a natural disaster zone, the less religious its people are expected to be.

Note that I calculate the shortest distance to each disaster zone and thus all units that are located within one disaster zone obtain a disaster-distance of zero. Hence, the main part of

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[22]Further, I cannot use data on losses from natural disasters, as losses are highly endogenous to economic development, which in itself might correlate with religiousness.

[23]Digitalized by United Nations Environmental Programme/Global Resource Information Database (UNEP/GRID), available online at http://geodata.grid.unep.ch/.

[24]Made available online at U.S. Geological Survey: http://www.usgs.gov/.

[25]The data was produced digitally by the Smithsonian Institution's Global Volcanism Program, http://www.volcano.si.edu/index.cfm.
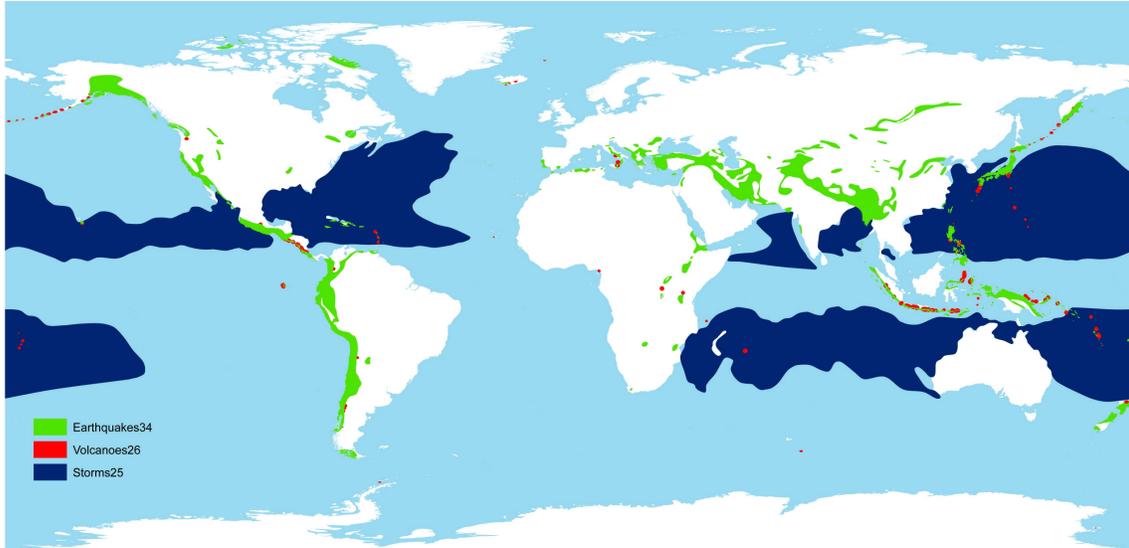
Figure 1: The natural disaster zones used for the empirical analysis. *Source*: Own compilation of earthquake layer from http://geodata.grid.unep.ch/, tropical storm layer from http://www.usgs.gov/, and volcano layer from http://www.volcano.si.edu/index.cfm, all of which are digitalizations of parts of the World Map of Natural Hazards from MunichRe pictured in Appendix Figure A1.

the variation in *disasters* comes from areas that are not directly hit by natural disasters, but are just located close to these areas. The means that the estimated β can be interpreted as the impact of disasters on units that are located close to a disaster, but are not devastated by it. For robustness, I exclude the zeroes in Table 7 with no change to my results.

The region with the lowest disaster frequency in my sample is the region of Bahia, a region on the Eastern tip of Brazil, located 2,650 km from the nearest disaster zone, which is the earthquake zone located on the Westcoast of South America. Many regions obtain a disaster distance of zero as they are located within one of the disaster zones. Examples are Sofia in Bulgaria, Kanto region of Japan, and Jawa Tengah in Indonesia.

3.3   Religiousness and disasters across the World

Table 2 shows the results from estimating equation (1) across 70,000-114,000 individuals from 473-610 subnational regions of the world. The religiousness measure is the Religiousity Scale

calculated from the following six religiousness measures (when nothing else is indicated, they are dummy variables with 1="yes", 0="no"): (1) How important is God in your life? (0="not at all important",..., 1="very important"), (2) Do you get comfort and strength from religion?, (3) Do you believe in God?, (4) Are you a religious person? (0="convinced atheist", 0.5="not a religious person", 1="religious person"), (5) Do you believe in life after death?, and (6) How often do you attend religious services? (0="Never, practically never", ..., 1="More than once a week").

The last three columns replicate the first three, accounting for country-fixed effects. Column (1) includes only demographic controls (sex, age and year of interview).[26] The estimate on disaster-distance is highly significant and of the expected sign: individuals living in regions that are more frequently hit by natural disasters, are more religious.

Column (2) includes individuals' education and income levels. These are ordered categorical variables constructed by the pooled WVS/EVD; income ranges from 1-10 deciles, while education ranges from 1-8, where 1 indicates "Inadequately completed elementary education" and 8 indicates "University with degree / Higher education". These are potentially important controls, as income and education might be influenced by natural disasters (see e.g. Albala-Bertrand (1993)), and at the same time might influence religiousness according to the modernization hypothesis (e.g., Inglehart & Baker (2000)). Indeed, this concern seems relevant; the estimate on disaster-frequency halves when including income and education. Wealthier and more educated individuals are less religious and also seem to be living in areas less frequently hit by natural disasters. The estimate of interest remains highly significant. Obviously, education and income are potentially endogenous to religiousness; perhaps more religious individuals are more hard working, trusting etc. and thus able to earn higher incomes, as shown by e.g., Guiso *et al.* (2003).

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[26]The parameter estimate and standard errors are the same without any controls: -0.16 (0.02) and R2 is 0.038.

Table 2. OLS of religiousness on disasters

VARIABLES	(1) rel	(2) rel	(3) rel	(4) rel	(5) rel	(6) rel
Dist(disaster), 1000km	-0.16***	-0.08***	-0.05**	-0.06***	-0.04**	-0.05***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Age	0.00	-0.00**	0.00***	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Male	-0.07***	-0.05***	-0.05***	-0.07***	-0.05***	-0.05***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Year	-0.00***	0.01***	0.00***	-0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Education		-0.01***	-0.00***		-0.00***	-0.00***
		(0.00)	(0.00)		(0.00)	(0.00)
Income		-0.01***	-0.00***		-0.00***	-0.00***
		(0.00)	(0.00)		(0.00)	(0.00)
Absolute latitude			-0.00***			-0.00
			(0.00)			(0.00)
Dist(coast), 1000km			0.03			0.05***
			(0.02)			(0.02)
Observations	114,278	69,928	69,928	114,278	69,928	69,928
R-squared	0.07	0.05	0.16	0.31	0.31	0.31
Country FE	N	N	N	Y	Y	Y
Continent	N	N	Y	N	N	N
Regions	610	473	473	610	473	473
Countries	73	57	57	73	57	57

Notes. OLS estimates. The dependent variable is the Religiosity Scale, which is an average (principal components analysis) of answers to the following questions on religiousness (when nothing else is indicated, they are dummy variables with 1="yes", 0="no"): (1) How important is God in your life? (0="not at all important",..., 1="very important"), (2) Do you get comfort and strength from religion?, (3) Do you believe in God?, (4) Are you a religious person? (0="convinced atheist", 0.5="not a religious person", 1="religious person"), (5) Do you believe in life after death?, and (6) How often do you attend religious services? (0="Never, practically never", ..., 1="More than once a week"). The unit of analysis is individuals surveyed in the pooled WVS / EVS. Dist(disaster) measures the distance to the nearest disaster-zone (earthquakes, volcanoes, or tropical storms) as depicted in Figure 1. Country FE indicates whether country fixed effects are included. Continent indicates whether or not six continent dummies are included (Africa, Asia, Australia, Oceania, Europe, North America, and South America). The standard errors are clustered at the level of subnational regions. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level.

Since the disaster measure is a distance-measure and since a large part of the disaster zones are located close to the ocean, one may worry that β is contaminated by some correlation between distance to the ocean and religiousness. Therefore, distance to the ocean is included in column (3). Further, I include continent-dummies and absolute latitude as a catch-all of additional geographic variables (I include various other geographic measures in Table 8). Again, the estimate on disaster distance is unchanged.

Getting at the size of the impact, individuals living in regions located 1000 km closer to a

disaster-zone tend to be 5 percentage points more religious. The median region in this sample is located 74 km from a disaster zone and the median individual has a level of religiousness of 87.9%. Increasing the distance to a disaster zone by 500 km brings the region to the 80th percentile in the disaster-distance distribution, and reduces the religiousness from the 50th to the 40th percentile.[27] This seems economically significant and also plausible.

The AV-plot in Figure 2 corresponds to the regional-level version of column (3) (i.e., column (3) of Table B1) and confirms that the result does not seem to be driven by individual observations. The group of 7 observations in the lower middle/right corner is 7 regions of Vietnam and excluding these does not alter the result. Neither does excluding the 68 outliers detected by the hadimvo procedure.
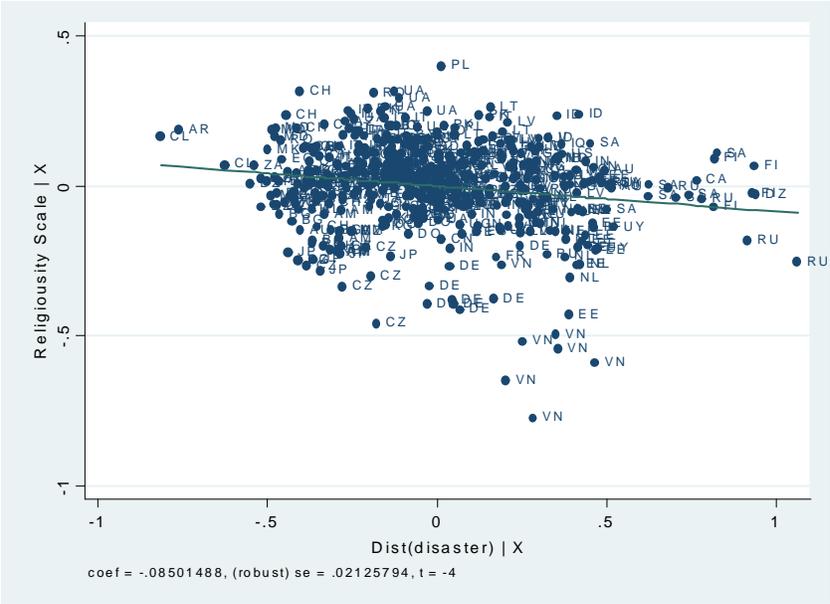
Figure 2. AV-plot corresponding to column (3) of Table B1, the cross-regional counterpart of column (3) of Table 2. The labels are countries.

One may worry that natural disasters influence countrywide institutions or culture in some way, which correlate with religiousness. Columns (4) through (6) include country-fixed effects to account for this. There is no difference between the estimates in columns (3) and (6), indicating that the main impact from natural disasters on religiousness seems to work within countries.

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[27]This calculation increases disasters from 0.074 (median) to 0.574 (85th percentile), which is 0.5 units. This reduces religiousness by $\beta \cdot 0.5$ ($= 0.5 \cdot 0.05 = 0.025$) units from 0.879 (median) to 0.854 (40th percentile).

The estimates in Table 2 are clusterred at the subnational region level to account for spatial dependence. Another way to account for spatial dependence is to average religiousness across regions. Results are provided in Appendix table B1, confirming the individual level results.[28]

I continue the analysis using country-fixed effects and all the baseline controls included in column (6) of Table 2. Income and education are potentially endogenous to religiousness, but all results are robust to excluding the two.

3.3.1   What kind of religiousness?

A next step is to analyze what types of religiousness is influenced by natural disasters. This is depicted in Table 3, where the first six columns include the measures entering the Religiousity Scale measure, while the last six columns are additional measures of religiousness from the pooled WVS/EVS. All baseline controls are included together with country fixed-effects. For robustness, Appendix Table B3 shows the results excluding education and income from the list of controls; all parameter estimates increase in absolute size and significance increase as well due to increased number of observations.

Of the 12 included religiousness measures in Table 3, all have the expected sign and all but three are distinguishable from zero at the 5% level (the three least significant religiousness measures are prayer/meditation, attendance at religious services, and getting comfort from religion). Judging by the size of the estimates, the religiousness measures that are most influenced by natural disasters are beliefs in sin, afterlife, hell and heaven. Judging instead by the explanatory power of the model (R^2), the measures influenced the most by disasters are importance of God in individuals' lives, and beliefs in Heaven and Hell.

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[28]The reason that the parameter estimates differ between the individual level regressions and the aggregated regional-regressions is two-fold; first, the individual-level controls such as age are aggregated to the regional level in Table B1, and second, the number of included regions differ, since individuals who lack information on e.g. age will drop out from the individual-level analysis, but will be included in the regional-aggregates as long as they have information on religiousness and as long as someone else in that region has information on age.

Table 3. Varying measures of religiousness

VARIABLES	(1) impgod	(2) comfort	(3) believe	(4) rel_pers	(5) after	(6) service	(7) sin	(8) hell	(9) heaven	(10) devil	(11) soul	(12) pray
Dist(disaster), 1000km	-0.05***	-0.04*	-0.05**	-0.04**	-0.10***	-0.04*	-0.14***	-0.10***	-0.08***	-0.08**	-0.07***	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)	(0.04)	(0.04)	(0.03)	(0.04)	(0.03)	(0.02)
Observations	150,564	83,869	88,122	145,182	82,143	147,292	47,089	82,696	83,462	44,716	85,347	82,136
R-squared	0.39	0.22	0.23	0.19	0.22	0.26	0.11	0.30	0.32	0.17	0.17	0.24
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Regions	805	482	475	802	475	788	333	474	475	333	475	502
Countries	78	57	57	77	57	76	40	57	57	40	57	53

Notes. OLS estimates. The dependent variable is answers to the following questions on religiousness (unless otherwise indicated, these are dummy variables with 1="yes", 0="no", the rest is ordered categorical variables, which I rescaled to lie between zero and one): (1) How important is God in your life? (0="not at all important",..., 1="very important"), (2) Do you get comfort and strength from religion?, (3) Do you believe in God?, (4) Are you a religious person? (0="convinced atheist", 0.5="not a religious person", 1="religious person"), (5) Do you believe in life after death?, (6) How often do you attend religious services? (0="Never, practically never", ..., 1="More than once a week"), (7) Do you believe in Sin?, (8) Do you believe in Hell?, (9) Do you believe in Heaven?, (10) Do you believe in the devil?, (11) Do you believe in a soul?, and (12) Do you take moments of prayer / meditation? The unit of analysis is individuals surveyed in the pooled WVS / EVS. Dist(disaster) measures the distance to the nearest disaster-zone as depicted in Figure 1. All regressions include country fixed effects (Country FE), education, income, age, year, sex, absolute latitude, and distance to coast (Baseline controls). All standard errors are clustered at the subnational region level. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level.

The results are supported by Appendix Table B2 which shows the results corresponding to those of Table 3, aggregated across regions. And further in Appendix Table B4, which estimates Table 3-type of regressions using probit estimation for those religiousness measures that are dummy variables and order logit for the ordered categorical variables. In both of the Appendix Tables, the impact on religious services becomes insignificant.

3.3.2 Religious denominations

The literature investigating religiousness and its' economic impact is primarily performed by Westernes, i.e. by people from Christian cultures. Thus, the religiousness measures in Tables 1, 2 and 3 are likely to measure Christian religiousness and not religiousness within other major religions. Hence, a concern is that Tables 2 and 3 document some relation between disasters and Christianity and not religiousness in general. To investigate this concern, Table 5 allows the impact of disaster-distance to vary across the major religions (i.e., estimating equation (3)). The major religions included are Christianity, Islam, Buddhism, and Hinduism, depicted

in Table 4, which also shows that the pooled WVS/EVS is fairly representative of the actual distribution of the major religions across the globe (last column).

Table 4. Major religions

Denomination	Number	Pct.	Pct. in World
Christianity	73,547	59.75	38.78
Islam	34,418	27.96	24.46
Buddhism	3,944	3.20	6.80
Hinduism	6,799	5.52	15.43
Other	4,385	3.56	14.53
Total	123,093	100.00	100.00

The distribution of the major religions in the pooled WVS/EVS compared to the true global distribution.

I generate 5 new variables $distaster \cdot I_g$, where I_g is an indicator-dummy equal to 1 if individual i belongs to religion g and zero otherwise. We learn from Table 5 that all 12 religiousness measures within Christianity are influenced in the expected direction, 6 signficantly so. Within Islam, 11 out of 12 measures are influenced in the expected direction, 9 significantly so. Within Buddhism, 9 out of 12 measures are influenced in the expected direction, 4 significantly so. Within Hinduism, only 3 religiousness measures are influenced in the expected direction, none of which are distinguishable from zero. Further, finding comfort from religion and taking moments of prayer / meditation is influenced significantly in the wrong direction. The finding of many insignificant estimates within Hinduism might be due to the fact that this is the religious denomination within which the natural disaster measure varies the least.[29] This cannot explain why I obtain estimates of the wrong sign, though, and one might conclude that hindus do not engage in religious coping as a reaction to natural disasters, but it could also be that I have not included the correct measures of religiousness that capture religiousness specifically within Hinduism. Within Other religions, 6 out of 12 religiousness measures have the correct sign, 2 of these significantly so. In this group, 2 measures are influenced significantly with the "wrong" sign. Unfortunately, the main part of this category is in fact coded by the pooled WVS/EVS as "Other" and so I cannot uncover this further.[30]

We further learn from Table 5 that only three of the 12 religiousness measures are influenced in the wrong direction across the majority of denominations, only two of these significantly so.

[29] The standard deviation on the disaster measure is 0.183 within Hinduism and 0.415 within Christianity, which is the religious denomination within which the disaster measure varies the most.

[30] In particular, out of the total number of 5,955 individuals in this category, 3,638 answered "Other" in the pooled WVS / EVS. The second largest group is ancestral worshipping with 883 individuals.

These measures are finding comfort in religion, frequency of attending religious services and prayer / meditation. None of these are influenced in the wrong direction within *all* denominations, though. Further, three religiousness measures are influenced in the expected direction across *all* denominations: Belief in afterlife, Hell, and the Devil - all beliefs that are related to thoughts of death. Beliefs in sin, Heaven and a soul have the expected sign within all but one denomination, Hinduism. Of these 6, only one measure was included in Inglehart & Norris (2003) Religiousity Scale used in Table 2. Their measure, thus, does not seem to perform well when the purpose is to measure religiousness across all religious denominations.

Table 5. Within religious denominations

VARIABLES	(1) impgod	(2) comfort	(3) believe	(4) rel_pers	(5) after	(6) service	(7) sin	(8) hell	(9) heaven	(10) devil	(11) soul	(12) pray
Dist(distaster)*Christian	-0.03***	-0.02	-0.01	-0.02**	-0.06*	-0.03	-0.12***	-0.06	-0.03	-0.03	-0.06***	-0.03*
	(0.01)	(0.02)	(0.01)	(0.01)	(0.03)	(0.02)	(0.04)	(0.05)	(0.03)	(0.04)	(0.02)	(0.02)
Dist(distaster)*Muslim	-0.04*	-0.02	-0.04**	-0.00	-0.15**	0.02	-0.37***	-0.29***	-0.15**	-0.39**	-0.10**	-0.04*
	(0.02)	(0.04)	(0.02)	(0.02)	(0.07)	(0.03)	(0.12)	(0.10)	(0.06)	(0.15)	(0.04)	(0.03)
Dist(distaster)*Buddhist	-0.04	0.18	-0.34***	-0.09*	-0.00	0.07	-0.21	-0.10	-0.22*	-0.30***	-0.07	0.11
	(0.05)	(0.11)	(0.09)	(0.05)	(0.09)	(0.06)	(0.13)	(0.13)	(0.12)	(0.11)	(0.09)	(0.09)
Dist(distaster)*Hindu	0.06	0.19**	0.08	0.06	-0.05	0.06	0.13	-0.03	0.01	-0.12	0.10	0.12*
	(0.09)	(0.09)	(0.06)	(0.07)	(0.21)	(0.09)	(0.17)	(0.13)	(0.13)	(0.13)	(0.15)	(0.06)
Dist(distaster)*Other	0.07**	0.06	0.03	0.00	-0.11	0.04	-0.17***	-0.13	-0.11	-0.10	-0.14***	0.11**
	(0.03)	(0.06)	(0.03)	(0.03)	(0.07)	(0.05)	(0.06)	(0.08)	(0.07)	(0.09)	(0.05)	(0.05)
Observations	123,093	70,336	73,460	118,849	68,137	119,810	37,802	68,508	69,270	35,841	70,818	69,771
R-squared	0.32	0.15	0.14	0.12	0.19	0.23	0.09	0.26	0.28	0.16	0.16	0.20
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Regions	790	463	465	786	465	765	333	464	465	333	465	500
Countries	77	56	56	76	56	75	40	56	56	40	56	53

Notes. OLS estimates. The dependent variable is answers to the following questions on religiousness (when nothing else is indicated, they are dummy variables with 1="yes", 0="no"): (1) How important is God in your life? (0="not at all important",..., 1="very important"), (2) Do you get comfort and strength from religion?, (3) Do you believe in God?, (4) Are you a religious person? (0="convinced atheist", 0.5="not a religious person", 1="religious person"), (5) Do you believe in life after death?, (6) How often do you attend religious services? (0="Never, practically never", ..., 1="More than once a week"), (7) Do you believe in Sin?, (8) Do you believe in Hell?, (9) Do you believe in Heaven?, (10) Do you believe in the devil?, (11) Do you believe in a soul?, and (12) Do you take moments of prayer / meditation. The unit of analysis is individuals surveyed in the pooled WVS / EVS. Dist(distaster)*Christianity measures distance to nearest disaster zone for Christians, and is equal to zero for all others. Likewise for the remaining Dist(distaster)*religion measures. All regressions include country fixed effects (Country FE), education, income, age, year, sex, absolute latitude, and distance to coast (Baseline controls, and denomination dummies. All standard errors are clustered at the subnational region level. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level.

3.3.3 Continents

As an additional robustness check, Table 6 allows the impact of disaster distance to vary across continents by including the variables $disaster \cdot I_g$, where I_g, where I_g is a dummy variable equal to one if the individual lives on that particular continent. The impact of disaster frequency has the expected sign for most religiousness measures across continents. The number of correct signs within each continent: 12 out of 12 in Africa, 9 out of 12 in Asia, 10 out of 12 in Australia/Oceania, 12 out of 12 in Europe, 7 out of 12 in North America, and 10 out of 12 in South America. None of the religiousness measures are influenced significantly in the wrong direction.

Further, the impact of disasters does not differ significantly across continents for 8 out of 12 religiousness measures (see the F-test in the bottom of the table).

Table 6. Within continents

VARIABLES	(1) impgod	(2) comfort	(3) believe	(4) rel_pers	(5) after	(6) service	(7) sin	(8) hell	(9) heaven	(10) devil	(11) soul	(12) pray
Dist(disaster)*Africa	-0.05***	-0.02	-0.04***	-0.01	-0.16***	-0.05	-0.25*	-0.31***	-0.06**	-0.26*	-0.06***	-0.07*
	(0.02)	(0.03)	(0.01)	(0.03)	(0.04)	(0.05)	(0.14)	(0.07)	(0.03)	(0.14)	(0.02)	(0.04)
Dist(disaster)*Asia	-0.06	0.13**	0.03	-0.13*	0.09	-0.03	0.32**	0.05	0.05	0.08	0.12	0.03
	(0.08)	(0.06)	(0.04)	(0.07)	(0.14)	(0.07)	(0.14)	(0.09)	(0.08)	(0.13)	(0.11)	(0.06)
Dist(disaster)*Australia	-0.01	-0.06	-0.02	0.01	-0.01	0.03	-0.18***	-0.10*	-0.09	-0.09	-0.05**	-0.03
	(0.03)	(0.05)	(0.04)	(0.03)	(0.05)	(0.03)	(0.04)	(0.06)	(0.06)	(0.06)	(0.02)	(0.03)
Dist(disaster)*Europe	-0.10**	-0.17***	-0.13***	-0.09**	-0.16***	-0.09*	-0.18***	-0.12***	-0.17***	-0.07	-0.13***	-0.15**
	(0.05)	(0.04)	(0.05)	(0.04)	(0.05)	(0.05)	(0.05)	(0.04)	(0.05)	(0.05)	(0.04)	(0.08)
Dist(disaster)*N America	-0.07	0.00	-0.01	0.01	-0.19**	-0.04	-0.15	0.12	-0.08	0.20	-0.17**	0.01
	(0.05)	(0.04)	(0.02)	(0.03)	(0.07)	(0.05)	(0.15)	(0.10)	(0.07)	(0.12)	(0.07)	(0.02)
Dist(disaster)*S America	-0.02	-0.07	0.00	-0.03	-0.08	-0.02	-0.13*	-0.00	-0.01	-0.02	-0.12*	0.04
	(0.02)	(0.10)	(0.04)	(0.02)	(0.07)	(0.03)	(0.07)	(0.09)	(0.10)	(0.07)	(0.07)	(0.03)
Observations	150,564	83,869	88,122	145,182	82,143	147,292	47,089	82,696	83,462	44,716	85,347	82,136
R-squared	0.39	0.22	0.23	0.19	0.22	0.26	0.11	0.30	0.32	0.17	0.17	0.24
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Regions	805	482	475	802	475	788	333	474	475	333	475	502
Con1=...=con6	0.544	0.000819	0.128	0.169	0.0841	0.310	0.0339	0.00154	0.219	0.128	0.0482	0.0406

Notes. OLS estimates. The dependent variable is answers to the following questions on religiousness (when nothing else is indicated, they are dummy variables with 1="yes", 0="no"): (1) How important is God in your life? (0="not at all important",..., 1="very important"), (2) Do you get comfort and strength from religion?, (3) Do you believe in God?, (4) Are you a religious person? (0="convinced atheist", 0.5="not a religious person", 1="religious person"), (5) Do you believe in life after death?, (6) How often do you attend religious services? (0="Never, practically never", ..., 1="More than once a week"), (7) Do you believe in Sin?, (8) Do you believe in Hell?, (9) Do you believe in Heaven?, (10) Do you believe in the devil?, (11) Do you believe in a soul?, and (12) Do you take moments of prayer / meditation? The unit of analysis is individuals surveyed in the pooled WVS / EVS. Dist(disaster) measures the distance to the nearest disaster-zone (earthquakes, volcanoes, or tropical storms) as depicted in Figure 1. Dist(disaster)*continent measures the disaster distance within continent Africa, Asia,

24

3.3.4 Updated religiousness measures

From Tables 3 and 5 I construct two updated religiousness measures. Religiousity Scale 2: the factor analysis weighted average of the 3 religiousness measures with a "correct" sign across all religious denominations in Table 5; beliefs in afterlife, Hell, and the Devil. The correlation between Religiousity Scale 2 and Religiousity Scale is 61.4. Religiousity Scale 3: the factor analysis weighted average of the 4 religiousness measures with a "correct" sign across all continents in Table 6; importance of God, beliefs in an afterlife, heaven and a soul. The correlation between Religiousity Scale 3 and Religiousity Scale is 89.6.

3.4 Particular types of natural disasters

Table 7 investigates whether the three disaster types exert different influences on religiousness. Columns (1)-(4) use the original Religiousity Scale from Table 2 (importance of God in your life, find comfort in religion, believe in God, are you a religious person, believe in life after death, and frequency of attending religious services) columns (5)-(8) use Religiousity Scale 2 (Belief in afterlife, Hell, and the Devil), while columns (9)-(12) use the Religiousity Scale 3 (importance of God, beliefs in an afterlife, heaven and a soul).

Examining first the combination of the three disaster-types in columns (1), (5), and (9), Religiousity Scales 2 and 3 are influenced the most by natural disasters. This was expected since Religiousity Scale 2 and 3 include religiousness measures which are most uniformly influenced across religious denominations and continents, respectively. All disaster-measures influence all religiousness measures negatively, but which of the components dominate varies across the different religiousness measures. Distance to earthquakes dominate when using the Religiousity Scale and Religiousity Scale 3. On average, earthquakes seem most important, and then comes volcanoes or storms. This ranking seems consistent with the literature on the uncertainty hypothesis, which stresses that people refer to their religion as a reaction to *unforeseeable* adverse life events, which might explain why storms are less important; tropical storms are rather foreseeable, returning at the same time of year every year. Volcanoes on the other

25

hand are highly unforeseeable, but rather rare, which might explain their insignificance for two out of three religiousness measures. Last, earthquakes are both unforeseeable and yet rather frequent.

The size of the disaster impact doubles when using Religiousity Scale 2 compared to the two other measures. Some of this is due to the reduced sample size though; when reducing the sample to that of the Religiousity Scale 2 measure, the columns (1) and (9) estimates increase slightly to 0.06.

Table 6. Varying disaster measures

VARIABLES	(1) rel	(2) rel	(3) rel	(4) rel	(5) rel2	(6) rel2	(7) rel2	(8) rel2	(9) rel3	(10) rel3	(11) rel3	(12) rel3
Dist(disaster), 1000km	-0.05***				-0.10***				-0.08***			
	(0.02)				(0.04)				(0.02)			
Dist(earthq), 1000km		-0.05***				-0.05				-0.08***		
		(0.01)				(0.03)				(0.02)		
Dist(volcano), 1000km			0.00				-0.06**				-0.02	
			(0.01)				(0.03)				(0.01)	
Dist(storm), 1000km				-0.01				-0.04				-0.02*
				(0.01)				(0.02)				(0.01)
Observations	69,928	69,928	69,928	69,928	40,566	40,566	40,566	40,566	77,037	77,037	77,037	77,037
R-squared	0.31	0.31	0.31	0.31	0.20	0.20	0.20	0.20	0.37	0.37	0.37	0.37
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes. OLS estimates. The dependent variable in columns (1)-(4) is the Religiousity Scale measure, which is an average (principal components analysis) of the following measures of religiousness: importance of God in your life, find comfort in religion, believe in God, are you a religious person, believe in life after death, and frequency of attending religious services. The dependent variable in columns (5)-(8) is the Religiousity Scale 2 measure, which is an average (principal components analysis) of the following 3 measures of religiousness: beliefs in life after death, Hell, and the Devil. The dependent variable in columns (9)-(12) is the Religiousity Scale 3 measure, which is an average (principal components analysis) of the following 4 measures of religiousness: importance of God, and beliefs in an afterlife, heaven, and a soul. The unit of analysis is individuals surveyed in the pooled WVS / EVS. Across columns, Dist(disaster) varies from including the shortest distance to any disaster-zone (earthquakes, volcanoes, or tropical storms) in columns (1), (5), and (9) only earthquakes in columns (2), (6), and (10) only volcanoes in columns (3), (7), and (11), and only storms in columns (4), (8), and (12). All regressions include country fixed effects (Country FE), education, income, age, year, sex, absolute latitude, and distance to coast (Baseline controls). Standard errors are clustered at the subnational region level. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level.

3.5 Additional controls

Additional concerns may be that areas with lower disaster frequency are more densely populated, which might somehow correlate with religiousness, that disaster areas differ from other

areas in terms of arable land shares, country size, average temperatures, average precipitation and variation therein, which might influence religiousness. I construct regional-level controls for all of these. Last, given the construction of the disaster measure, one may be concerned that the result is driven by the difference between zero disaster distance and "the rest". Table 8 includes these potentially relevant additional controls and also restricts the sample to only include non-zero disaster distances in column (9). The estimate of disaster frequency stays remarkably stable at 0.05 with a standard error of 0.02 throughout columns (1)-(10). The results are robust to using Religiousity Scale 2 in column (11) and Religiousity Scale 3 in column (12). In accordance with the work by Ager & Ciccone (2012), I find that increased within-year variation in precipitation increases religiousness when using the Religiousity Scale measure (columns 7 and 10).[31] The hypothesis by Ager & Ciccone (2012) relates to church-going, which is not included in Religiousity Scales 2 and 3, which might be why the variation in precipitation has no significant influence on these two measurs. I find no support for the hypothesis by Snarey (1996) who argued that societies located in areas under environmental conditions of exreme scarcity (measured by scarcity of rain) are more likely to believe in High Gods that legitimize moral codes designed to protect natural resources. Further, none of the included controls seem to exert an independent effect on religiousness when included simultaneously using the Religiousity Scale 2 measure. Using the remaining two religiousness measures, the evidence suggests that individuals are less religious when living in larger regions, more densely populated regions, regions with larger shares of arable land, and regions with lower average temperatures.

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[31]Further, as expected according to the hypothesis by Ager & Ciccone (2012), I find that variance of precipitation has no impact in the sample with arable land shares below the median (indicating less dependency on agriculture historically). The impact of natural disaster remains unchanged in this sample (results are available upon request).

Table 7. Additional controls

VARIABLES	(1) rel	(2) rel	(3) rel	(4) rel	(5) rel	(6) rel	(7) rel	(8) rel	(9) rel	(10) rel	(11) rel2	(12) rel3
Dist(disaster), 1000km	-0.05***	-0.05***	-0.05***	-0.05***	-0.05***	-0.05***	-0.05***	-0.05***	-0.05***	-0.05***	-0.11***	-0.08***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.04)	(0.02)
Popdens 2000		-0.00***								-0.00**	0.00	-0.00
		(0.00)								(0.00)	(0.00)	(0.00)
Arable land (%)			-0.01							-0.02**	-0.03	-0.02**
			(0.01)							(0.01)	(0.03)	(0.01)
Area 1000km				-0.00***						-0.00***	-0.00	-0.00***
				(0.00)						(0.00)	(0.00)	(0.00)
Avg temp 1961-90					0.00					0.00	0.00	0.00**
					(0.00)					(0.00)	(0.00)	(0.00)
Prec 1961-90						0.00				-0.01	-0.02	-0.01
						(0.01)				(0.01)	(0.03)	(0.02)
Var(prec) 1961-90							0.07**			0.11*	0.14	0.09
							(0.03)			(0.06)	(0.17)	(0.07)
Disaster>0									0.01	0.01	0.00	0.00
									(0.01)	(0.01)	(0.02)	(0.01)
Observations	69,928	69,866	69,928	69,928	69,095	69,095	69,095	69,928	49,945	69,095	39,640	76,133
R-squared	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.21	0.38
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sample	full	full	full	full	full	full	full	full	nonzero	full	full	full

Notes. OLS estimates. The dependent variable in columns (1)-(10) is the Religiousity Scale measure, which is an average (principal components analysis) of the following measures of religiousness: importance of God in your life, find comfort in religion, believe in God, are you a religious person, believe in life after death, and frequency of attending religious services. The dependent variable in column (11) is the Religiousity Scale 2 measure, which is an average (principal components analysis) of the following 3 measures of religiousness: beliefs in life after death, Hell, and the Devil. The dependent variable in column (12) is the Religiousity Scale 3 measure, which is an average (principal components analysis) of the following 4 measures of religiousness: importance of God, and beliefs in an afterlife, heaven, and a soul. The unit of analysis is individuals surveyed in the pooled WVS / EVS. All regressions include country fixed effects (Country FE), education, income, age, year, sex, absolute latitude, and distance to coast (Baseline controls). Sample indicates whether it is the full sample or the sample restricted to non-zero disaster-distances. Standard errors are clustered at the subnational region level. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level.

3.6 Religiousness of 2nd generation immigrants

So far, the estimated impact from natural disasters on religiousness might have come from selection; it could be the case that atheists move out of natural disaster areas to a larger extent than religious people, who see the disaster as a punishment from God and therefore not something which can be dealt with by relocating. Further, I might have omitted important subnational-level confounders that bias the estimate of interest.

In order to isolate the direct causal impact of natural disasters on religiousness from that of selection and other omitted factors, I exploit data from the European Social Survey in order

to employ the epidemiological approach in estimating equation (4) (e.g., Fernandez (2011)). The dependent variable is the religiousity of second generation immigrants risiding in Europe and the disaster measure is the distance to natural disaster zones from the mothers country of origin. The European Social Survey provides three measures of religiousness; people who (1) pray weekly or more often (columns (1)-(4) of Table 8), (2) identify themselves as religious (columns (5)-(8)), and (3) attend religious services regularly (columns (9)-(12)). The dataset comprises 6062 second generation immigrants whose mothers come from 142 different countries.

Columns (1)-(4) of Table 8 show that second generation immigrants whose mother comes from a country located closer to a disaster zone pray more often than second generation immigrants whose mothers came from less disaster prone countries. This is true controlling for country fixed effects (of the immigrants' current country of residence), geographical factors in the mothers' country of origin (absolute latitude, continents and distance to the coast, column 2), parent characteristics (mother's and father's education, column 3), individual-controls (immigrant's age, sex, year of interview, income, education, column 4). To a lesser extent, second generation immigrants whose mother came from a country frequently hit by natural disasters rank themselves as more religious. This might be due to differences across continents, though. The impact on attending religious services turns insignificant when including geographic and individual controls. Frequency of natural disasters does not seem to induce people to attend religious services, which quite extraordinarily was also one of the least influenced religiousness measures in the analysis across World regions above. It seems that people do not engage in coping activities (church), but instead cope with the stress from natural disasters in a more spiritual way by increased beliefs etc. I have found similar tendencies in one micro study by psychologists, Koenig *et al.* (1988).

The results are unchanged when using instead ordered logit estimation (see Appendix Table B5).

Table 8. OLS of religiousness on disasters in mothers' home country

VARIABLES	(1) pray	(2) pray	(3) pray	(4) pray	(5) rel_pers	(6) rel_pers	(7) rel_pers	(8) rel_pers	(9) service	(10) service	(11) service	(12) service
Dist(disaster), 1000km	-0.09***	-0.06**	-0.07***	-0.09*	-0.08***	-0.04	-0.07***	-0.08**	-0.05***	-0.01	-0.05***	-0.03
	(0.02)	(0.03)	(0.02)	(0.05)	(0.02)	(0.03)	(0.02)	(0.04)	(0.02)	(0.02)	(0.02)	(0.03)
Observations	5,971	5,962	5,148	2,118	6,002	5,993	5,175	2,121	6,037	6,028	5,203	2,140
R-squared	0.14	0.15	0.16	0.22	0.08	0.10	0.10	0.16	0.10	0.11	0.11	0.15
Org countries	142	124	124	124	142	124	124	124	142	124	124	124
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Geo controls	N	Y	N	N	N	Y	N	N	N	Y	N	N
Indl controls	N	N	N	Y	N	N	N	Y	N	N	N	Y
Parent controls	N	N	Y	N	N	N	Y	N	N	N	Y	N
No. controls	29	37	31	34	29	37	31	34	29	37	31	34

Notes. OLS estimates. The dependent variable is an ordered categorical measure of religiousness (scaled to lie between 0 and 1) varying across columns, including answers to the questions: How often do you pray? (0="Never", ..., 1="Every day") in columns (1)-(4), How religious are you? (1="Not at all religious", ..., 1="Very religious") in columns (5)-(8), and How often do you attend religious services? (0="Never", ..., 1="Weekly or more often") in columns (9)-(12). Dist(disaster) measures the distance to the nearest disaster-zone (earthquakes, volcanoes, or tropical storms) as depicted in Figure 1. The unit of analysis is second generation immigrants residing in Europe. "Country FE" indicates whether country fixed effects of the immigrants current country of residence are included. "Geo controls" indicates whether or not six continent dummies (Africa, Asia, Australia and Oceania, Europe, North America, and South America), absolute latitude, and distance to coast are included. "Parent controls" indicates inclusion of mother's and father's level of education. "Indl controls" indicates inclusion of education, income, age, year of interview, and sex of the second generation immigrant. All regressions include country fixed effects (Country FE). Standard errors are clustered at the level of immigrant's current country and mothers' country of origin. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level.

The size of the impact is not significantly different from the effect found in the World analysis; if anything, the effect is larger in the second generation immigrants regressions. The selection effect can thus not explain the effect from natural disasters on religiousness. It seems that at least some of the impact stems from the tendency for relgious people to refer to their religion when faced with adverse life events (the Uncertainty hypothesis) and/or the tendency for human beings to search for reason in natural phenomena and thus for instance to explain natural disasters by God's punishment (the Acts of God hypothesis).

3.7 Conclusion

I find that individuals living in areas more frequently hit by natural disasters are more likely to believe in God, sin, afterlife etc. The size of the effect is quite large; individuals living in regions located 500 km further away from a disaster zone are 2.5 percentage points less religious.

This amounts to a reduction from the median to the 40th percentile in the distribution of religiousness. The impact is not implausibly large though; a difference of 500 km amounts to the difference between the median and the 80th percentile in the distance distribution.

Frequency of natural disasters increase religiousness within Christianity, Islam, and Buddhism. With the present data, hindus do not seem to engage in religious coping as a reaction to natural disasters. Natural disaster frequency increase religiousness within all continents. The impact of disasters is not due to a selection effect or omitted variables bias; I find that second generation immigrants whose mothers lived their lives in areas of high disaster frequency pray more often compared to their counterparts from calmer areas. I interpret this as a tendency for religious people to turn to their religion when faced with adverse life events (religious coping). But also as a tendency for non-religious people to potentially become convinced that a God exists when they live among strong natural forces.

The influence from natural disasters stems mainly from closeness to earthquake zones, and to a lesser extent to volcano zones and tropical storm zones. This ranking seems consistent with the literature on the uncertainty hypothesis, which stresses that people refer to their religion as a reaction to *unforeseeable* adverse life events, which might explain why storms are less important; tropical storms are rather foreseeable, returning at the same time of year every year. Volcanoes on the other hand are highly unforeseeable, but rather rare, which might explain their insignificance for two out of three religiousness measures. Last, earthquakes are both unforeseeable and yet rather frequent.

This research contributes to the understanding of the origins of differences in religiousness. And at the same time, it provides one explanation of the apparent paradox that religiousness does not seem to vanish with increased wealth and knowledge as suggested by the modernization hypothesis. Specifically, Frazer (1920) proposed that with the development of science, many natural phenomena previously interpreted in supernatural terms become understandable in terms of natural forces that are predictable and potentially controllable. In line with a more recent literature (e.g., Stark & Bainbridge (1985)), the present study shows that natural disasters still influence religiousness, in spite of increased wealth and knowledge.

Further, if religiousness is rooted in the uncertainty of our natural surroundings, and if the impact found in the present study extends to other natural phenomena, climate change may have a yet unexplored consequence; namely increased religious beliefs.

A Data

Steps in matching geographic data with the regional information in the pooled WVS/EVS:

1. The disaster data is available at the grid-cell level, while the finest spatial information in the pooled WVS/EVS is variable x048 indicating the region where the interview was conducted. The WVS/EVS "regions" can be both actual regions, but in a few cases also cities. To match the two types of information, I use a shapefile from ESRI with first administrative regions across the globe, which means a unit of disaggregation just below the country-level.

2. The ESRI-shapefile also has information on the type of land, which is: primary land, large island, medium island, small island, very small island. To prevent averaging across for instance islands and primary land, I rank the five categories with primary land as the preferred and very small island as the least preferred. In those cases, where a region is divided into several polygons, I keep only the highest ranked polygon. I.e., if for instance a region consists of one primary land polygon and one very small island, I keep only the primary land polygon. Just averaging over the entire mix of land polygons makes no difference for the results.

3. The x048 variable varies across time in most cases. For instance, the same country can be divided into 15 regions in one year and only five larger regions in another year. I the cases with more than one year, I pick the year with the finest level of disaggregation or the year that matches the ESRI shapefile better.

4. For many countries, the level of aggregation in the ESRI shapefile is different from that in the regional identifyer, x048, from EVS/WVS. In these cases, I aggregate to the finest level possible.

Variable	Description	Source
Earthquake zones	The earthquake intensity zones are based on the probability of earthquake occurrence of a certain intensity measured on the 1956 version of the Modified Mercalli Scale (MM). The risk grading is based on expectations for a period of 50 years.	Digitalized by United Nations Environmental Programme/Global Resource Information Database (UNEP/GRID), available online at http://geodata.grid.unep.ch/.
Tropical storm zones	The five wind speed categories are: 1) 118-153 km/h, 2) 154-177 km/h, 3) 178-209 km/h, 4) 210-249 km/h, and 5) 250+ km/h. The Storm Intensity Zone layer shows areas where each of these wind speed categories has s a 10% probability of occurring within the next 10 years.	Made available online at U.S. Geological Survey: http://www.usgs.gov/.
Volcano density zones	The volcanic eruptions were rated using the Volcanic Explosivity Index (VEI), which is a simple 0-to-8 index of increasing explosivity, with each successive integer representing about an order of magnitude increase.	The data was produced digitally by the Smithsonian Institution's Global Volcanism Program, http://www.volcano.si.edu/index.cfm.

B Alternative estimation techniques

Table B1. OLS of religiousness on disasters across regions

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	rel	rel	rel	rel	rel	rel
Dist(disaster), 1000km	-0.14***	-0.11***	-0.09***	-0.07**	-0.06*	-0.08**
	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)	(0.03)
Age	-0.02***	-0.02***	-0.01***	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Male	0.05	0.12	0.02	-0.21***	-0.19*	-0.20*
	(0.10)	(0.10)	(0.11)	(0.08)	(0.11)	(0.11)
Year	0.00*	0.00*	0.01***	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Education		-0.02**	-0.00		-0.01	-0.01
		(0.01)	(0.01)		(0.01)	(0.01)
Income		-0.01	-0.01		-0.01	-0.01
		(0.01)	(0.01)		(0.01)	(0.01)
Absolute latitude			-0.00			-0.00
			(0.00)			(0.00)
Dist(coast), 1000km			0.04*			0.11**
			(0.02)			(0.04)
Observations	617	517	517	617	517	517
R-squared	0.41	0.46	0.54	0.87	0.86	0.87
Country FE	N	N	N	Y	Y	Y
Continent	N	N	Y	N	N	N
No. countries	73	61	61	73	61	61

Notes. OLS estimates. The dependent variable is the Religiousity Scale, which is an average (principal components analysis) of the proportion of the population in a region who: (1) say that God is "very important" in their lives, (2) find comfort in religion, (3) believe in God, (4) identify themselves as religious, (5) believe in life after death, and (6) attend religious services regularly. The unit of analysis is World subnational regions. Dist(disaster) measures the distance to the nearest disaster-zone (earthquakes, volcanoes, or tropical storms) as depicted in Figure 1. Country FE indicates whether country fixed effects are included. Continent indicates whether or not six continent dummies are included (Africa, Asia, Australia, Oceania, Europe, North America, and South America). The standard errors are the standard robust Huber-White sandwich estimators, and in columns (4)-(6), they are clustered at the country level. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level.

33

Table B2. OLS of varying measures of religiousness on disasters across regions

VARIABLES	(1) impgod	(2) comfort	(3) believe	(4) rel_pers	(5) after	(6) service	(7) sin	(8) hell	(9) heaven	(10) devil	(11) soul	(12) pray
Dist(disaster), 1000km	-0.06**	-0.07**	-0.09**	-0.05	-0.08**	0.01	-0.19**	-0.11**	-0.10**	-0.15**	-0.09***	-0.11*
	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.03)	(0.08)	(0.04)	(0.04)	(0.07)	(0.03)	(0.06)
Observations	830	537	519	826	519	812	385	518	519	345	482	317
R-squared	0.89	0.87	0.83	0.80	0.82	0.85	0.65	0.87	0.87	0.71	0.76	0.80
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y

Notes. OLS estimates. The dependent variable varies across columns and is the proportion of the population in a region who: (1) say that God is "very important" in their lives, (2) find comfort in religion, (3) believe in God, (4) identify themselves as religious, (5) believe in life after death, and (6) attend religious services regularly, believe in (7) sin, (8) hell, (9) heaven, (10) the Devil, and (11) a soul, and (12) takes moments of prayer / meditation. The unit of analysis is subnational regions. Dist(disaster) measures the distance to the nearest disaster-zone as depicted in Figure 1. All regressions include country fixed effects (Country FE), education, income, age, year, sex, absolute latitude, and distance to coast (Baseline controls). All standard errors are clustered at the country level. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level.

Table B3. Varying measures of religiousness excluding income and education controls

VARIABLES	(1) impgod	(2) comfort	(3) believe	(4) rel_pers	(5) after	(6) service	(7) sin	(8) hell	(9) heaven	(10) devil	(11) soul	(12) pray
Dist(disaster), 1000km	-0.06***	-0.08***	-0.06***	-0.04**	-0.12***	-0.04**	-0.15***	-0.12***	-0.09***	-0.10***	-0.07***	-0.06***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)
Observations	215,697	140,217	144,284	209,618	133,436	214,293	97,064	135,017	136,066	57,959	103,372	135,118
R-squared	0.38	0.23	0.21	0.19	0.19	0.26	0.15	0.29	0.28	0.18	0.16	0.21
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Baseline2 controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Regions	909	630	612	905	612	891	481	611	612	358	491	664
Countries	90	73	73	89	73	88	59	73	73	43	58	74

Notes. OLS estimates. The dependent variable is answers to the following questions on religiousness (unless otherwise indicated, these are dummy variables with 1="yes", 0="no", the rest is ordered categorical variables, which I rescaled to lie between zero and one): (1) How important is God in your life? (0="not at all important",..., 1="very important"), (2) Do you get comfort and strength from religion?, (3) Do you believe in God?, (4) Are you a religious person? (0="convinced atheist", 0.5="not a religious person", 1="religious person"), (5) Do you believe in life after death?, (6) How often do you attend religious services? (0="Never, practically never", ..., 1="More than once a week"), (7) Do you believe in Sin?, (8) Do you believe in Hell?, (9) Do you believe in Heaven?, (10) Do you believe in the devil?, (11) Do you believe in a soul?, and (12) Do you take moments of prayer / meditation? The unit of analysis is individuals surveyed in the pooled WVS / EVS. Dist(disaster) measures the distance to the nearest disaster-zone as depicted in Figure 1. All regressions include country fixed effects (Country FE), age, year, sex, absolute latitude, and distance to coast (Baseline2 controls). All standard errors are clustered at the subnational region level. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level.

Table B4. Ordered logit and probit of varying measures of religiousness on disasters

VARIABLES	(1) impgod	(2) comfort	(3) believe	(4) relpers	(5) after	(6) service	(7) sin	(8) hell	(9) heaven	(10) devil	(11) soul	(12) pray
Dist(disaster), 1000km	-0.33**	-0.13	-0.16	-0.40***	-0.31***	-0.19	-0.45***	-0.31***	-0.24**	-0.23**	-0.31***	-0.06
	(0.15)	(0.09)	(0.13)	(0.15)	(0.12)	(0.13)	(0.14)	(0.12)	(0.11)	(0.10)	(0.11)	(0.07)
Observations	150,564	82,991	84,818	145,182	78,840	147,292	46,356	79,392	80,158	43,983	82,043	82,136
Estimation	ologit	probit	probit	ologit	probit	ologit	probit	probit	probit	probit	probit	probit
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Regions	805	477	467	802	467	788	333	466	467	333	467	502
Countries	78	56	54	77	54	76	39	54	54	39	54	28

Notes. Ordered logit and probit estimates. The dependent variable is the Religiousity Scale, which is an average (principal components analysis) of the proportion of the population in a region who: (1) say that God is "very important" in their lives, (2) find comfort in religion, (3) believe in God, (4) identify themselves as religious, (5) believe in life after death, and (6) attend religious services regularly, believe in (7) sin, (8) hell, and (9) heaven, (10) say that they are raised religiously, and (11) takes moments of prayer / meditation. The unit of analysis is subnational regions. Dist(disaster) measures the distance to the nearest disaster-zone as depicted in Figure 1. All regressions include country fixed effects (Country FE), education, income, age, year, sex, absolute latitude, and distance to coast (Baseline controls). All standard errors are clustered at the subnational region level. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level.

Table B5. Ordered logit of religiousness on disasters in mothers' home country

VARIABLES	(1) pray	(2) pray	(3) pray	(4) pray	(5) relpers	(6) relpers	(7) relpers	(8) relpers	(9) service	(10) service	(11) service	(12) service
Dist(disaster), 1000km	-0.46***	-0.29**	-0.39***	-0.52**	-0.46***	-0.21	-0.42***	-0.49**	-0.33***	-0.08	-0.35***	-0.28
	(0.10)	(0.14)	(0.08)	(0.20)	(0.11)	(0.17)	(0.12)	(0.20)	(0.09)	(0.11)	(0.09)	(0.18)
Observations	5,971	5,962	5,148	2,118	6,002	5,993	5,175	2,121	6,037	6,028	5,203	2,140
Org countries	142	124	124	124	142	124	124	124	142	124	124	124
Country FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Geo controls	N	Y	N	N	N	Y	N	N	N	Y	N	N
Parent controls	N	N	Y	N	N	N	Y	N	N	N	Y	N
Indl controls	N	N	N	Y	N	N	N	Y	N	N	N	Y
No. controls	29	37	31	34	29	37	31	34	29	37	31	34

Notes. Ordered logit estimates. The dependent variable is an ordered categorical measure of religiousness (scaled to lie between 0 and 1) varying across columns, including answers to the questions: How often do you pray? (0="Never", ..., 1="Every day") in columns (1)-(4), How religious are you? (1="Not at all religious", ..., 1="Very religious") in columns (5)-(8), and How often do you attend religious services? (0="Never", ..., 1="Weekly or more often") in columns (9)-(12). Dist(disaster) measures the distance to the nearest disaster-zone (earthquakes, volcanoes, or tropical storms) as depicted in Figure 1. The unit of analysis is second generation immigrants residing in Europe. "Country FE" indicates whether country fixed effects of the immigrants current country of residence are included. "Geo controls" indicates whether or not six continent dummies (Africa, Asia, Australia and Oceania, Europe, North America, and South America), absolute latitude, and distance to coast are included. "Parent controls" indicates inclusion of mother's and father's level of education. "Indl controls" indicates inclusion

of education, income, age, year of interview, and sex of the second generation immigrant. All regressions include country fixed effects (Country FE). Standard errors are clustered at the level of immigrant's current country. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level.

C   Figures
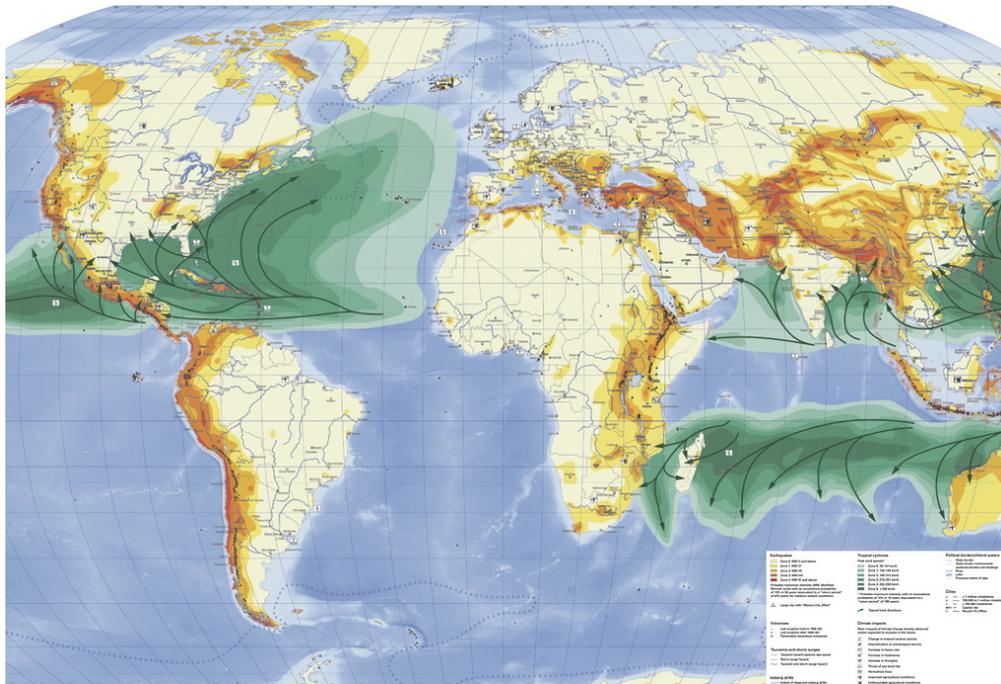
Figure A1. World Map of Natural Hazards. *Source*: MunichRe 1998.

References

Ager, P., & Ciccone, A. 2012. Rainfall Risk and Religious Membership in the Late Nineteenth&Century US.

Albala-Bertrand, J.M. 1993. *The political economy of large natural disasters: with special reference to developing countries*. Oxford: Clarendon Press.

Allport, G.W., & Ross, J.M. 1967. Personal religious orientation and prejudice. *Journal of personality and social psychology*, **5**(4), 432.

Andersen, T., Bentzen, J., Dalgaard, C.J., & Sharp, P. 2011. Religious orders and growth through cultural change in pre-industrial England. *Univ. of Copenhagen Dept. of Economics discussion paper.*

Angrist, J.D., & Pischke, J.S. 2008. *Mostly harmless econometrics: An empiricist's companion.* Princeton University Press.

Bering, J.M. 2002. The existential theory of mind. *Review of General Psychology*, **6**(1), 3.

Bering, J.M. 2006. The folk psychology of souls. *Behavioral and Brain Sciences*, **29**(05), 453–462.

Bering, J.M., McLeod, K., & Shackelford, T.K. 2005. Reasoning about dead agents reveals possible adaptive trends. *Human Nature*, **16**(4), 360–381.

Brown, D.E. 1991. *Human universals.* Temple University Press.

Bulbulia, J. 2004. The cognitive and evolutionary psychology of religion. *Biology and Philosophy*, **19**(5), 655–686.

Cohen, S., & Wills, T.A. 1985. Stress, social support, and the buffering hypothesis. *Psychological bulletin*, **98**(2), 310–357.

Cook, J.A., & Wimberley, D.W. 1983. If I should die before I wake: Religious commitment and adjustment to the death of a child. *Journal for the Scientific Study of Religion*, 222–238.

Fernandez, R. 2011. *Does culture matter?* The Netherlands: North-Holland.

Fichter, J.H. 1981. *Religion and pain: The spiritual dimensions of health care.* Crossroad Publishing Company.

Frazer, J.G. 1920. *The golden bough.* London: MacMillan & co.

Guiso, L., Sapienza, P., & Zingales, L. 2003. People's opium? Religion and economic attitudes. *Journal of Monetary Economics*, **50**(1), 225–282.

Guthrie, S.E. 1995. *Faces in the clouds: A new theory of religion.* Oxford University Press, USA.

Hall, D.D. 1990. *Worlds of wonder, days of judgment: Popular religious belief in early New England.* Harvard University Press.

Hultkrantz, A. 1979. *The religions of the American Indians.* Berkeley: University of California Press.

Iannaccone, Laurence R. 1998. Introduction to the Economics of Religion. *Journal of economic literature*, **36**(3), 1465–1495.

Inglehart, R., & Baker, W.E. 2000. Modernization, cultural change, and the persistence of traditional values. *American sociological review*, 19–51.

Inglehart, R., & Norris, P. 2003. *Rising tide: Gender equality and cultural change around the world.* Cambridge University Press.

Johnson, D.D.P. 2005. God's punishment and public goods. *Human Nature*, **16**(4), 410–446.

Kimball, Miles S, Mitchell, Colter M, Thornton, Arland D, & Young-Demarco, Linda C. 2009. *Empirics on the origins of preferences: The case of college major and religiosity.* Tech. rept. National Bureau of Economic Research.

Koenig, H.G., George, L.K., & Siegler, I.C. 1988. The use of religion and other emotion-regulating coping strategies among older adults. *The Gerontologist*, **28**(3), 303–310.

Lazarus, R.S., & Folkman, S. 1984. *Stress, appraisal, and coping.* Springer Publishing Company.

Malinowski, B. 1948. *Magic, Science and Religion: And Other Essays.* Beacon Press.

McCleary, R., & Barro, R. 2003. Religion and economic growth across countries. *American Sociological Review*, **68**, 760–781.

McCleary, R.M., & Barro, R.J. 2006. Religion and economy. *The Journal of Economic Perspectives*, **20**(2), 49–72.

McCrae, R.R. 1984. Situational determinants of coping responses: Loss, threat, and challenge. *Journal of Personality and Social Psychology*, **46**(4), 919.

Murdock, G.P. 1965. *Culture and society: twenty-four essays.* University of Pittsburgh Press.

Norenzayan, A., & Hansen, I.G. 2006. Belief in supernatural agents in the face of death. *Personality and Social Psychology Bulletin*, **32**(2), 174–187.

Ono, K. 1987. Superstitious behavior in humans. *Journal of the Experimental Analysis of Behavior*, **47**(3), 261.

Pargament, K.I. 2001. *The psychology of religion and coping: Theory, research, practice.* Guilford Press.

Park, C., Cohen, L.H., & Herb, L. 1990. Intrinsic religiousness and religious coping as life stress moderators for Catholics versus Protestants. *Journal of personality and social psychology*, **59**(3), 562.

Penick, J.L. 1981. *The New Madrid Earthquakes.* University of Missouri.

Schuster, M.A., Stein, B.D., Jaycox, L.H., Collins, R.L., Marshall, G.N., Elliott, M.N., Zhou, A.J., Kanouse, D.E., Morrison, J.L., & Berry, S.H. 2001. A national survey of stress reactions after the September 11, 2001, terrorist attacks. *New England Journal of Medicine*, **345**(20), 1507–1512.

Shariff, A.F., & Norenzayan, A. 2007. God Is Watching You Priming God Concepts Increases Prosocial Behavior in an Anonymous Economic Game. *Psychological Science*, **18**(9), 803–809.

Siebert, L., & Simkin, T. 2002. Volcanoes of the world: An illustrated catalog of Holocene volcanoes and their eruptions. *Smithsonian Institution, Global Volcanism Program, Digital Information Series GVP-3 (http://www. volcano. si. edu/world).*

Skinner, B.F. 1948. 'Superstition'in the pigeon. *Journal of experimental psychology*, **38**(2), 168.

Snarey, J. 1996. The natural environment's impact upon religious ethics: A cross-cultural study. *Journal for the scientific study of religion*, 85–96.

Sosis, R. 2008. Pigeons, foxholes, and the book of Psalms. *Bulbulia et al., eds., Evolution of Religion*, 103–109.

Stark, R., & Bainbridge, W.S. 1985. *The future of religion: Secularization, revival, and cult formation.* Univ of California Press.

Steadman, L.B., & Palmer, C.T. 1995. Religion as an identifiable traditional behavior subject to natural selection. *Journal of Social and Evolutionary systems*, **18**(2), 149–164.

Steinberg, T. 2006. *Acts of God: The unnatural history of natural disaster in America*. Oxford University Press, USA.

Taylor, S.E. 1983. Adjustment to threatening events: A theory of cognitive adaptation. *American psychologist*, **38**(11), 1161.

Tu, Qin, Bulte, Erwin, & Tan, Shuhao. 2011. Religiosity and economic performance: Micro-econometric evidence from Tibetan area. *China Economic Review*, **22**(1), 55–63.

Van De Wetering, M. 1982. Moralizing in Puritan natural science: Mysteriousness in earthquake sermons. *Journal of the History of Ideas*, 417–438.

Weber, M. 1905. *The Protestant Ethic and the Spirit of Capitalism*. Penguin Books.

Williams, D.R., Larson, D.B., Buckler, R.E., Heckmann, R.C., & Pyle, C.M. 1991. Religion and psychological distress in a community sample. *Social Science & Medicine*, **32**(11), 1257–1262.

Wooldridge, J. 2002. *Econometric Analysis of Cross Section and Panel Data*.