Acts of God? Religiosity and Natural Disasters Across Subnational World Districts

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Abstract

Religiosity affects everything from fertility and health to labor force participation and productivity. But why are some societies more religious than others? To answer this question, I rely on the religious coping theory, which states that many individuals draw on their religious beliefs to understand and deal with adverse life events. In fact, philosophers have long maintained that *all* religions evolve to provide individuals with a higher power to turn to in times of hardship. Combining subnational district level data on values across the globe with spatial data on natural disasters, I find that individuals became more religious when their district was hit recently by an earthquake. Furthermore, even though they tend to revert back towards their long-run level of religiosity after a while, data on children of immigrants in Europe documents that this effect persists across generations. The impact is global: earthquakes increase religiosity both within Christianity, Islam, and Hinduism, and within all continents. The results point to religious coping as the main mediating channel, as opposed to selection or physical insurance. The paper contributes, among other things, to the expanding literature investigating the roots of various "useful" cultural values.

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1 Introduction

The majority of the World population is religious. 69% regard themselves as religious and 83% believe in God and this matters for the decisions we make.[1] Indeed, differences in religiosity have been associated with differences in, e.g., fertility, labor force participation, education, crime, redistribution policies, and health, and even with rather aggregate economic outcomes such as GDP per capita growth.[2] A first order question is thus: Why are some societies more religious than others?

To answer this question, I rely on the idea that religion serves as social insurance against hard times. In theory, religion can provide both *physical* insurance in terms of food, aid etc. provided by the church and *psychological* insurance in terms of the comfort and meaning that beliefs in a higher power can grant believers when faced with unbearable situations. The main part of the empirical results in the current paper are driven by the latter. The idea that religion provides psychological insurance is also termed religious coping and has been emphasized by psychologists, anthropologists, and sociologists as an important part of religion.[3,4] Praying to God for relief or attributing the event to an act of God are examples of religious coping. This literature is not trying to reduce religion to a matter of coping, but when asking the religious "What do you seek from religion?", "meaning" and "comfort" are among the most common reasons indicated (Clark (1958), Pargament (2001)). In an attempt to validate the theory, existing empirical evidence shows that individuals hit by various adverse life events are more religious and that prayer is often chosen by various

[1] Source: the last decade of the pooled World Values Survey and European Values Study 2004-2014.

[2] For economic correlates of religiosity, see Guiso *et al.* (2003), Gruber (2005), and Gruber & Hungerman (2008) for empirical investigations or Iannaccone (1998), Lehrer (2004), and Kimball *et al.* (2009) for reviews. See Scheve & Stasavage (2006) for impacts of religiosity on redistribution policies. For papers on the impact of religiosity on aggregate growth rates, see McCleary & Barro (2006) or Campante & Yanagizawa-Drott (2013).

[3] The idea of religion as psychological insurance has historically been emphasized by scholars such as Feuerbach (1957), Malinowski (1948), Freud (1927), Marx (1867). More recently, it was put into a textbook by Pargament (2001) and another book by Norris & Inglehart (2011). The theory has also received support from political scientists and economists, e.g., Scheve and Stasavage 2006 and Clark and Lelkes 2005.

[4] What I label religious coping has been called many things across time, space, and academic disciplines. For instance, the religious comforting hypothesis or the religious buffering hypothesis. Also the uncertainty hypothesis is a special case of religious coping. I choose the term religious coping from within psychology, used by, among others, the psychologist Kenneth Pargament in his influential book about religious coping, Pargament (2001).

hospitalized patients above seeking information, going to the doctor, or taking prescription drugs.[5]

This paper surmounts a major empirical challenge: being hit by adverse life events is most likely correlated with unobserved individual characteristics (such as lifestyle), which in turn may matter for the individual's inclination to be religious.[6] Furthermore, by conducting the analysis on a global sample, this study explores the contention of thinkers, such as Karl Marx and Sigmund Freud, that *all* religions evolve to provide individuals with a higher power to turn to in times of hardship.[7] So far, the samples used in the empirical literature are either narrow subsets of a population or a few regions in Western countries.

This paper exploits natural disasters as a source of exogenous adverse life events that hit individuals across the globe at varying strengths. The main natural disaster used is earthquakes.[8] Across 600-900 subnational districts of the World, I first show that individuals are more religious when living in districts hit more frequently by earthquakes, even accounting for actual recent earthquakes. The measure of religiosity is based on six particular values that the father of the World Values Survey, Ronald Inglehart, and his co-author argue accounts for the global variation in religiosity (Inglehart & Norris (2003)). The measure includes answers to questions such as "How important is God in your life?" or "Do you believe in an Afterlife?" from the pooled World Values Survey / European Values Study. I control for country and time fixed effects as well as various individual and district level characteristics. The estimates indicate that reducing earthquake risk by 1.5 standard deviations reduces religiosity by 0.4 standard deviations (or 6 percentage points). This amounts to reducing the religiosity in the Alentejo district in Southern Portugal to the Hessen district of central Germany. The tendency is global: Christians, Muslims, and Hindus all exhibit higher religiosity in response to elevated earthquake risk, and so do inhabitants of every continent.

A concern is that important district-level factors have been left out of the analysis, biasing

[5] See e.g., Ano & Vasconcelles (2005), Pargament *et al.* (1990), and Pargament (2001) for reviews. See Conway (1985) for the ranking of different coping strategies.

[6] Some recent micro studies do address the endogeneity concern in small samples. E.g., Norenzayan & Hansen (2006) in a study of 28 western students and Sibley & Bulbulia (2012) analysing the impact of the Christchurch earthquake across 5 regions of New Zealand.

[7] Feuerbach (1957), Freud (1927), Marx (1867), Norris & Inglehart (2011).

[8] Among all natural disasters, earthquakes are particularly useful to analyze as they have proven to be impossible to predict and since data on earthquakes is of a high quality. Other types of disasters such as wars, economic crises, and epidemic diseases cannot be regarded as natural experiments; they are endogenous to various factors, which potentially biases the results. In relation to the religious coping literature, earthquakes are more likely than, for example, storms to instigate increased faith due to their unpredictable nature, which will be exploited for identification.

the results. To address this concern, I exploit the time-dimension of the data to confirm the causal effect: District-level religiosity increases when an earthquake hits. The results are robust to country-by-year fixed effects, individual level controls etc., and rather comforting, future earthquakes have no impact on current religiosity. The fact that, in the moderne World, earthquakes can still instigate intensified believing is illustrated by a Gallup survey conducted in the aftermath of the great 1993 Mississippi River floods. The survey asked Americans whether the recent floods were an indication of God's judgement upon the sinful ways of the Americans: 18 % answered in the affirmative (Steinberg (2006)).

Consistent with a literature on dynamic effects of various shocks on cultural values, I find evidence that the short term spike in religiosity after an earthquake levels off after a while. However, the analysis documents a highly persistent residual impact: Children of immigrants are more religious when their parents came from a country in a high earthquake risk zone, independent of the actual earthquake risk in their current country of residence. It seems that living in high-earthquake risk areas instigates a culture of religiosity that is passed on to future generations like any other cultural value. Standard models of cultural transmission predict that only cultural traits that are beneficial in some way will be passed on.[9] Indeed, studies find that religious individuals often have better mental health (Miller *et al.* (2014), Park *et al.* (1990)), higher life satisfaction and are happier (Ellison *et al.* (1989), Campante & Yanagizawa-Drott (2013)), are better able to cope with adverse life events (e.g., Clark & Lelkes (2005)), and engage less in deviant behavior (Lehrer (2004)). The existence of a long term effect of earthquake risk is corroborated in the cross-district analysis: The impact of long term earthquake risk is unaltered when controlling for actual recent earthquakes, but is smaller in districts that were hit by an earthquake within the last year.

To test whether the results are a manifestation of psychological insurance, I carry out a set of detailed consistency checks. First, mainly intrinsic religiosity is affected and to a lesser extent church going across all three analyses. This is in line with the psychological insurance idea, where studies show that religious *beliefs* are used to a larger extent than church going to cope with adverse life events. Further, religious beliefs also seem to be more efficient in reducing symptoms such as depression, compared to church going which does not provide the same health benefits.[10] If the results were driven by the church providing physical insurance, we would have expected church attendance to be affected. Second, ac-

[9] See e.g., model by Bisin & Verdier (2001).

[10] E.g., Miller *et al.* (2014), Koenig *et al.* (1988), Koenig *et al.* (1998).

cording to the literature on religious coping, individuals use their religion to cope mainly with unpredictable events, and less so with predictable ones.[11] Consistent with this, I find that tsunamis and volcanoes increase religiosity just as earthquakes, while storms, which are seasonal and thus much more predictable, do not imply increased believing. Since storms are just as detrimental as earthquakes in terms of monetary losses and death tolls, people should engage in physical insurance as a reaction to earthquakes and storms, alike. And we would have expected storms to have similar effects on religiosity were the results driven by physical insurance. In addition, I find that an earthquake that strikes a low risk district has a larger impact on religiosity compared to an earthquake that hits a high-risk district, which is in line with the idea that unpredictable events instigate psychological insurance. Third, the study of children of immigrants documents an inter-generational spillover of the effect of earthquakes, indicating cultural transmission, which is more difficult to explain in light of physical insurance. Fourth, the impact of increased earthquake risk persists after controlling for actual earthquakes and also when restricting the sample to the districts that are not actually hit by earthquakes; people living in districts located closer to high-risk areas, but not actually hit, are more religious.[12] If physical insurance was the only channel, we would have expected the actual recent earthquakes to be driving the results, not long term earthquake risk. Both are consistent with a psychological response; earthquakes striking nearby can affect family members, friends and relatives, and generally increase individuals' awareness of the devastating effects of earthquakes. Fifth, empirical tests of the religious coping hypothesis show that individuals with access to more alternative coping strategies (both monetary and social) tend to engage less in religious coping. Corroborating this, I find that the religiosity of educated, employed, and married individuals increases less with earthquake risk compared to less educated, unemployed, and unmarried individuals. Also consistent with the literature, I find that these groups do react to earthquakes by increased believing, though to a lesser extent.[13] Viewed in isolation, these latter results are also consistent with the physical insurance hypothesis, but the results for education and employment hold after controlling for income and I find no interaction effects with income. Thus, it seems that

[11] E.g., Malinowski (1948), Hood Jr (1977), Skinner (1948). This has later been termed the uncertainty hypothesis.

[12] Restricting the sample to districts that are not actually hit by earthquakes also takes care of an additional concern; that areas hit frequently by earthquakes have historically attracted a special type of people, compared to areas not hit by earthquakes, and that these people are more inclined to respond to earthquakes by increased believing than other people. In that case, we would have expected the effect to fall when throwing away the earthquake areas.

[13] See e.g., Koenig *et al.* (1988) and review by Pargament (2001).

education and employment provide other things than monetary resources; e.g., knowledge and networks. This speaks to a psychological effect, rather than a physical one.

The uncovered results are unlikely to be generated by selection; i.e. the notion that "non-believers" systematically abandon earthquake sites, thereby elevating the average district level religiosity in the aftermath of an earthquake. First, the results from the event study are difficult to explain in this context: I find a spike in religiosity after an earthquake, which abates over time. If this is due to selection, it requires atheists to move out every time an earthquake hits, but then move back in again after some time, only to move out again when the next earthquake hits. The spike *can* be explained in relation to religious coping: Praying reduces the stress caused by the earthquake, leveling off the need for prayer after a while. Second, if selection was the only thing going on, we would expect those moving out of high-earthquake-risk areas to be less religious. Assuming some passing on of values from adults to children, we would expect that children of immigrants from these areas were *less* religious. The results show that they are *more* religious.[14] Third, selection seems inconsistent with the finding that religiosity is less related to earthquake risk when a recent earthquake has hit. We would have expected the opposite: being hit again and again by earthquakes makes it more likely that people abandon these areas. Fourth, if the results were driven by migration, we would expect the effect to be smaller across larger districts, where it is less likely that moving away from the earthquake area means moving out of the district. This does not seem to be the case; the impact of earthquakes does not depend on the size of the districts.

This research informs about the origins of differences in religiosity across societies. Societies located in earthquake areas have developed a culture of higher religiosity, which is passed on through generations. Further, if an exogenous deep determinant of religiosity exists, and is still at play today, this might help explain the fact that religiosity has not declined greatly with increased wealth and knowledge as the modernization hypothesis otherwise suggests.[15] More speculatively, the short-term effects may be useful to predict fluctuations in fundamentalism.

Other studies have investigated the impact of various shocks on religiosity. Ager & Ci-

[14] A proper investigation of the issue would be to compare immigrants' religiosity to the religiosity of the inhabitants of their country of origin. I have not found a way to do so.

[15] It is disputed whether religiosity has declined at all. Iannaccone (1998) reviews numerous analyses of cross-sectional data to conclude that neither religious belief nor religious activity tends to decline with income, and that most rates tend to increase with education. Norris & Inglehart (2011) note that many of these studies are done within America, which seems to be a special case compared to the rest of the World, where they document a fall in religiosity.

ccone (2014) show that American counties faced with higher rainfall variability saw higher rates of church membership in 1900. Their interpretation is that the church acts as physical insurance against risk, making membership of religious organizations more attractive in high-risk environments. Even more related to the current study, Ager *et al.* (2014) show that church membership increased in the aftermath of the 1927 Mississippi River floods. Exploiting the fact that rice-growers suffered less than average during the Indonesian financial crisis, Chen (2010) finds that households who suffered more from the crisis were more religious. Clark & Lelkes (2005) find that the religious suffer less psychological harm from unemployment and divorce, consistent with a story of psychological insurance. Related to this literature, Hungerman (2005) shows that charitable contributions to members of the US Presbyterian church have been negatively correlated with levels of state welfare spending. Scheve & Stasavage (2006) shows that religiosity and redistributive policies are substitutes, arguing that aggregate charitable giving is too small to account for the observed effects. They argue instead that the main reason is that religion provides psychic insurance.

This study relates more broadly to a growing literature investigating the endogenous emergence of potentially useful beliefs. The literature has linked differences in gender roles to past agricultural practices (Alesina *et al.* (2013)), individualism to past trading strategies (Greif (1994)), trust to the slave trade in Africa, historical literacy, institutions, and climatic risk (Nunn & Wantchekon (2011), Tabellini (2010), Durante (2010)), anti-Semitism to the Black Death and temperature shocks (Voigtländer & Voth (2012), Anderson *et al.* (2013)), and time preference to geographical variation in natural land productivity (Galor & Özak (2014)), etc. The current study links a cultural value with evident implications for economic outcomes (religiosity) to one of its potential roots; disaster risk.

The paper is structured as follows. Section 2 reviews the literature on religious coping and sets up testable implications. Section 3 presents the data and documents the global impact of earthquakes on religiosity in three different analyses: Cross-subnational World districts, within-subnational World districts, and across children of immigrants in Europe. Across all three analyses, the results are validated in relation to the religious coping literature. Section 4 concludes.

2 Religious coping

The religious coping hypothesis claims that people use their religion to cope with adverse life events. This tendency has been observed within various fields from anthropological studies of indigenous societies to empirical analyses within sociology and psychology. I label this tendency "religious coping" in line with the psychology literature, noting that other terminologies have been invoked; e.g., religious buffering, the religious comfort hypothesis, psychological social insurance, etc.[16] Religious coping is much in line with the hypothesis by Norris & Inglehart (2011) on existential security. They observed that people who experience much existential insecurity tend to be more religious than those who grow up under safer, comfortable, and more predictable conditions.

Coping in general is a process through which individuals try to understand and deal with significant personal and situational demands in their lives (e.g., Lazarus & Folkman (1984), Tyler (1978)). Religious coping involves drawing on religious beliefs and practices to understand and deal with these life stressors (Pargament (2001)).[17] Examples can be seeking a closer relationship to God, praying, attempting to be less sinful, or searching for an explanation for the event; for example, tragedies can be interpreted as part of God's plan (Pargament (2001)).

Perhaps the first to observe that the extent of religious activity (or rituals and magic) varies between different natural circumstances was Bronislaw Malinowski, one of the fathers of ethnography, who lived with the Trobriand Islanders of New Guinea for several years around 1910 to study their culture (Malinowski (1948)). 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 that 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 interpreted the rituals as helping the islanders to cope with the stress involved with the unforeseen dangers of the open sea.[18]

Since Malinowski, numerous studies have found that people hit by severe adverse life

[16] The uncertainty hypothesis also involves religious coping, but concerns more specifically the fact that religious coping is more profound in unpredictable situations, which I shall return to.

[17] E.g., Pargament (2001), Cohen & Wills (1985), Park *et al.* (1990), Williams *et al.* (1991).

[18] Poggie Jr *et al.* (1976) arrived at similar conclusions: Asking fishermen to recall the number of ritual taboos practiced on a fishing trip, they found that longer trips instigated more rituals than shorter trips, involving less risk. Steadman & Palmer (1995) interpret the rituals slightly differently; as a signal of willingness to cooperate.

events such as cancer, heart problems, other severe illnesses, death in close family, alcoholism, divorce, injury, threats, accidents etc. tend to engage in religious coping.[19] In fact many studies find religious coping methods to be among the most common, if not the most common, ways of coping with stresses of various kinds.[20] Most studies are performed on small samples, but Clark & Lelkes (2005) find that across various European countries, individuals with a religious denomination experience a lower reduction in wellbeing from unemployment or divorce than do those without a religious denomination.

Being hit by adverse life events is most likely correlated with unobserved individual characteristics (such as lifestyle), which in turn may matter for the individual's inclination to be religious. Norenzayan & Hansen (2006) addressed this endogeneity problem by performing a controlled experiment of 28 undergraduate students from the University of Michigan. They primed half of the students with thoughts of death by having them answer questions such as "What will happen to you when you die?" and the other half with neutral thoughts by having them instead answer questions such as "What is your favorite dish?" The students primed with thoughts of death were more likely to reveal beliefs in God and to rank themselves as being more religious after the experiment.

Another way of addressing the endogeneity problem is to analyze the impact of natural disasters on the degree of religious beliefs as done in the current study.[21,22] Indeed, the belief that natural disasters carried a deeper message from God was the rule rather than the exception before the Enlightenment (e.g., Hall (1990), Van De Wetering (1982)). For instance, the famous 1755 Lisbon earthquake has been compared to the Holocaust as a catastrophe that transformed European culture and philosophy.[23] Penick (1981) investigated

[19] See e.g., Ano & Vasconcelles (2005), Pargament *et al.* (1990), and Smith *et al.* (2003) for reviews.

[20] See review by Pargament (2001). For instance, prayer often ranked above seeking information, resting, treatment, prescription drugs, and going to a doctor (Conway (1985)).

[21] I focus here exclusively on negative events. The religious coping literature broadly agrees that religion is mainly used to cope with negative events rather than positive. See for instance Pargament & Hahn (1986), Bjorck & Cohen (1993), Pargament *et al.* (1990), Smith *et al.* (2000).

[22] Other types of disasters are potentially relevant for religious coping. For the Maya and Inca "diseases were supposed to derive from crimes in the past - above all, theft, murder, adultery, and false testimony" (Hultkrantz (1979)). Fast forward in time, the Black Death that swept across Europe between 1347 and 1360 had a significant impact on religion, as many believed the plague was God's punishment for sinful ways (MacGregor (2011)). Analysing the September 11 attack, Schuster *et al.* (2001) found that 90% of the Americans surveyed reported that they coped with their distress by turning to their religion.

[23] See review by Ray (2004). In addition to being one of the deadliest earthquakes ever, it also struck on an important church holiday and destroyed many important churches in Lisbon, but spared the red light district. Due to this differential effect of the earthquake, many thinkers claim that the earthquake was associated with a decline in religiosity across Europe afterwards, making the earthquake an example of an adverse life event that leads to reduced believing. According to religious coping theory, shocks can both instigate leaving God and embracing him. Empirics show that the latter is the most common reaction, see

more systematically reactions to the massive earthquakes in 1811 and early 1812 that had their epicenters in Missouri, USA. In the year after the earthquake, church membership increased by 50% in Midwestern and Southern states, where the earthquakes were felt most forcefully, compared to an increase of only 1% in the rest of the United States. The Gallup survey after the US Midwest floods in 1993 mentioned in the introduction illustrates the contemporary relevance. Smith *et al.* (2000) asked the victims of the same floods about their religious coping in response to the disaster. Many reported that religious stories, the fellowship of church members, and strength from God helped provide the support they needed to endure and survive the flood. Even more recently, Sibley & Bulbulia (2012) show that religious conversion rates increased more in the Christchurch region after the 2011 Christchurch earthquake compared to the remaining four regions of New Zealand.

Elevated religiosity in the aftermath of disaster can be due to different types of religious coping. The 1993 Gallup survey, is an example where people interpret the disaster as a sign of God's anger, which provides them with stress relief: the World makes sense.[24] However, even if most people agree that tectonic plates, not God, cause earthquakes, they can still use their religion to cope with the stress and disorder felt after the disaster by believing more, praying, or going to church. Whichever religious coping mechanism is used, the outcome is the same and it can be turned into the first testable prediction:

Testable implication 1: Disasters increase religiosity.

The theory of religious coping can only inform about global differences in religiosity if religious coping is not something peculiar to, for example, Christianity. Indeed, there are reasons to believe that religious coping does not pertain to particular religious denominations, but that it is a global phenomenon. Pargament (2001) notes that (p3): "*While different religions envision different solutions to problems, every religion offers a way to come to terms with tragedy, suffering, and the most significant issues in life.*" Likewise, Norris & Inglehart (2011) stress that virtually all of the World's major religions provide reassurance that, even though the individual alone cannot understand or predict what lies ahead, a higher power will ensure that things work out. Hence, in theory religious coping is for adherents to all religions. However, the empirical studies of religious coping include mainly samples of individuals from Christian societies. One study did attempt to distinguish between coping across different

for instance review by Pargament (2001).

[24] 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)).

denominations: Gillard & Paton (1999) found that 89% of Christian respondents, 76% of Hindus, 63% of Muslims on Fiji responded that their respective beliefs were helpful after Hurricane Nigel in 1997.[25] This translates into a second prediction:

Testable implication 2: Religious coping is not specific to any religious denomination.

2.1 Differential uses of religious coping

Identifying a strong relationship between disasters and religiosity obviously cannot in and by itself be interpreted as religious coping. Such a relationship could be due to selection, a story of physical insurance, omitted confounders or something else. While the event study in Section 3.4 addresses most of this in the short term, the religious coping hypothesis can be investigated further by testing additional predictions from the literature. These are outlined below.

2.1.1 Believing versus churchgoing

Religious coping seems to involve mainly elevated believing rather than churchgoing. Koenig *et al.* (1988) found that the most frequently mentioned coping strategies among 100 older adults dealing with three stressful events were faith in God, prayer, and gaining strength from God. Social church-related activities were less commonly noted. Another indicator of whether religious coping is an efficient coping strategy is whether it leads to reduced stress. The medical study by Miller *et al.* (2014) mentioned earlier shows that importance of religion reduces depression risk (measured by cortical thickness), while frequency of church attendance had no effect on the thickness of the cortices. These findings were corroborated by Koenig *et al.* (1998) who found that time to remission was reduced among 111 hospitalized individuals engaging in intrinsic religiosity, but not for those engaging in church going.

Testable implication 3. Disasters increase believing more than church going.

2.1.2 Social or monetary alternatives

Religious people use religion in coping more than the non-religious.[26] This is part of a broader tendency for individuals to use the coping strategies most readily *available* and *compelling* to

[25] For further evidence expanding beyond Western societies, see Pargament (2001) for a review, Tarakeshwar *et al.* (2003) for evidence of religious coping among Hindus, and MacGregor (2011) for evidence of religious coping within Buddhism.

[26] See review by Pargament (2001) and study by Pargament *et al.* (1990) and Wicks (1990).

them (Pargament (2001)). Religious coping is just one coping strategy among many others, e.g., being with friends or family for stress relief, paying a psychiatrist, etc. Religious coping differentiates from these alternatives by (most often) demanding no monetary resources and by (sometimes) demanding no engagement from other people. That means that everyone, regardless of monetary or social resources, has access to religious coping. In that case, we expect individuals with fewer coping alternatives to engage in religious coping to a greater extent than those with more alternatives (Pargament (2001)). Along the same lines, Norris & Inglehart (2011) argue that feelings of vulnerability to physical, societal, and personal risks are a key factor driving religiosity.

The set of coping strategies available to individuals set of available coping strategies can be increased by both economic resources and social networks, providing access to someone to talk to in times of need. Likewise, Scheve & Stasavage (2006) argue that events such as job loss, divorce, or major sickness do not only impose monetary costs on individuals, they also create psychological costs. These psychological costs can involve damage to self-esteem, stress, or the loss of enjoyment from having a network of friends. Empirical evidence supports this proposition (e.g., Clark & Oswald (1994)).

It is not only the availability of the coping mechanism that is important, but also the degree to which the individual finds it compelling. Studies find that less educated individuals engage more in religious coping than educated individuals (e.g., Bearon & Koenig (1990), Gurin *et al.* (1960)). The reason could be the potentially additional resources that education provides, but also the social networks obtained, and in the specific case of earthquakes, the reason could be better knowledge about natural phenomena.

Testable implication 4: Religious coping is stronger among those with few (social or monetary) alternatives.

If people with more monetary resources use their religion less in response to adverse life events, this is also consistent with religion as physical insurance; those with more economic resources have less need for the material aid provided by the church. In fact, what I find is that income does not seem to matter, but what matters is marital status, employment status, and education.

2.1.3 Unpredictability

Religious coping is more prevalent as a reaction to unpredictable/uncontrollable events, rather than predictable ones.[27] This idea is called the uncertainty hypothesis and probably has its' roots in Malinowski's observation, mentioned earlier. The reasoning is that religious coping belongs to emotion-focused coping, which aims at reducing or managing the emotional distress arising from a situation, as opposed to problem-focused coping, which aims at doing something to alter the source of the stress.[28] A study of 1556 adults in Detroit coping with major life events or chronic difficulties found that religious coping was more common in dealing with illness and death than in dealing with practical and interpersonal problems (Mattlin *et al.* (1990)). Hood Jr (1977) asked high school students who were about to spend a solitary night in the woods to state how stressful they expected the night to be. The actual stressfulness of the night was determined by the weather; some nights it rained heavily and other nights were dry. Upon return, Hood found that religious mystical experiences were reported most often by students who anticipated a stressful night, but encountered no rain, and by the students who did not expect a stressful night, yet ran into a stormy evening.

It seems that the reaction to unpredictability extends into the animal world. Skinner (1948) found that pigeons who were subjected to an unpredictable feeding schedule were more likely to develop inexplicable (/superstitious ritual) behavior, compared to the birds not subject to unpredictability. Since Skinner's pioneering work, various studies have documented how children and adults in analogous unpredictable experimental conditions quickly generate novel superstitious practices (e.g., Ono (1987)).[29]

Testable implication 5: Unpredictable stressful events increase religiosity more than predictable ones.

2.2 Benefits of religious coping

Further corroborating the importance of religious coping, studies have found that religion does seem to help the victims by resulting in better physical functioning, less anxiety, better

[27] E.g., Norris & Inglehart (2011), Sosis (2008), Park *et al.* (1990).

[28] Folkman & Lazarus (1985), Folkman & Lazarus (1980). In general, Carver *et al.* (1989) identifies five distinct aspects of emotion-focused coping: Turning to religion, seeking of emotional social support, positive reinterpretation, acceptance, and denial, and five distinct aspects of problem-focused coping: Active coping, planning, suppression of competing activities, restraint coping, and seeking instrumental social support.

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

self-esteem, and lower levels of depression (see review by Smith *et al.* (2000)).[30] More recently, a medical study by Miller *et al.* (2014) shows that individuals who reported a higher importance of religion or spirituality had thicker cortices in the brain than those who reported moderate or low importance of religion or spirituality, meaning that the religious had a lower tendency for depression.

These health benefits of religion point to the possibility of persistency. The idea is that parents hit by adverse life events become more religious and pass on this higher religiosity to their children. In cultural transmission models, such as Bisin & Verdier (2001), the cultural trait is only transmitted to the children if it gives utility to either the parent or the children. The health benefits mentioned speak for such an effect. Additional studies show that religious people seem to enjoy higher life satisfaction and be happier (Ellison *et al.* (1989), Campante & Yanagizawa-Drott (2013)), be better at coping with various adverse life events (e.g., Clark & Lelkes (2005)), and also engage less in deviant behavior such as drug use and crime (Lehrer (2004)). All are values that most parents would like to transmit to their children.

Testable implication 6: Religiosity is a value that is passed on through generations.

3 Empirical analysis

The purpose of the empirical analysis is to show first that religiosity is higher for individuals living in high-earthquake risk areas across the entire globe (the cross-district study in Section 3.3), second that the impact is causal: individuals *become* more religious in the aftermath of an earthquake (the event study in Section 3.4), and third that a long-run impact exists: earthquakes instigate a culture of religiosity, which can be traced across generations (the persistency study in Section 3.5). To validate the results vis-a-vis the religious coping literature, I investigate the testable implications from Section 2 throughout.

3.1 Data on religiosity

The data on religiosity used in the main analysis (Sections 3.3 and 3.4) is the pooled World Values Survey (WVS) and European Values Study (EVS) carried out for 6 waves in the

[30] See another review by Pargament (2001), who found that three-quarters of the studies on religion and health confirmed a relationship between religious coping and better health and wellbeing. Smith *et al.* (2003) reviews 147 studies on the impact of religiosity on depressive symptoms and find that religiosity is mildly associated with fewer symptoms.

period 1981-2009.[31] This dataset includes information from interviews of 424,099 persons (representative of the general population in each country) residing in 96 countries.

In order to match the data from the pooled WVS-EVS with spatial data on natural disasters and other geographic confounders, I use information on the subnational district in which each individual was interviewed. I match this with a shapefile containing first administrative districts of the World.[32] In this way, I was able to place 212,157 of the individuals in a subnational district from the ESRI shapefile. This means 914 districts in 85 countries out of the original 96 countries, covering most of the inhabited parts of the World, depicted in Appendix Figure A1.[33]

The individuals in the pooled WVS-EVS were asked a multitude of questions concerning cultural values, including their religious beliefs. As my main measure of religiosity, I use the Strength of Religiosity Scale developed by Inglehart & Norris (2003) to span global variation in religiosity. The six indicators that enter the measure 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").[34] I rescaled all measures to lie between 0 and 1. Following Inglehart & Norris (2003), I rescaled answers to the question "Are you a religious person?" into a dummy variable with 1 indicating yes and 0 indicating no, as there are very few respondents answering that they are convinced atheists.[35] Following Inglehart & Norris

[31] Available online at http://www.worldvaluessurvey.org and http://www.europeanvaluesstudy.eu. After the first revision of this paper, an additional wave came out (2010-2014) for some of the religiosity measures. I show country-aggregates using the recent wave, but I have not gone through the cumbersome process of matching the information on the subnational districts to the geographic shapefile, which must be done a new for the new wave, since the district names are different from the previous waves. Furthermore, not all measures in the Strength of Religiosity Scale (the main measure of religiosity used throughout) are available in the new wave, which means that the results using the main religiosity measure, Strength of Religiosity Scale, will be unaltered.

[32] The shapefile is freely available at ESRI.com.

[33] The number of districts in a country ranges from 2 to 41. The mean (median) number of districts per country is 15.9 (14).

[34] The original variables were: (1): f063, (2): f064, (3): f050, (4): f034, (5): f051, and (6): f028. An earlier version of this paper includes additional measures of religiosity, arriving at the same conclusions.

[35] In addition, I changed the original categories for f028 about attendance at religious services, which originally ranged across 8 categories: More than once a week; once a week; once a month; only on special holy days/Christmas/Easter; other specific holy days; once a year; less often; never, practically never. I aggregated the two categories "only on special holy days/Christmas/Easter" and "other specific holy days", since there were very few observations in the latter and since it is not obvious how to rank the two.

(2003), I used factor component analysis to compress the six indicators into one measure, called $religiosity_{idct}$, for individual i living in subnational district d in country c, interviewed at time t.

The summary statistics for the 6 religiosity measures are summarized in Table 1 for the dataset used in the cross-sectional analysis in the first two columns where information on the subnational district is available, and for the full WVS-EVS dataset in the last two columns. The degree of religiosity is very similar in the two samples, which give support to the representativeness of the sample with information on the subnational district. We see that 84-87% of the respondents believe in God, 61-65% believe in life after death etc.

Table 1. Summary statistics of Inglehart's 6 religiosity measures

	Data with district information		Full WVS-EVS dataset	
Measure	N	Mean	N	Mean
How important is God in your life?[a]	203,514	.728	396,596	.680
Do you find comfort in God?	130,384	.738	287,553	.682
Do you believe in God?	134,201	.868	293,537	.838
Are you a religious person?	197,137	.711	385,416	.702
Do you believe in life after death?	123,968	.645	271,632	.601
How often do you attend religious services?[a]	201,674	.492	398,237	.468

Notes. The unit is an individual. All variables, except those marked with an a, are indicator variables. The two first columns show summary statistics for the dataset where information on the subnational district in which the individual was interviewed is available. The two last columns show the entire pooled WVS-EVS 1981-2009 dataset. Source: pooled EVS-WVS 1981-2009 dataset.

The average (median) district has 766 (466) respondents in total, or 335 (235) respondents per year of interview.[36]

The data on religiosity used in the persistency study is described in Section 3.5.

3.2 Data on long term earthquake risk

The main measure of earthquake risk in the cross-district study (Section 3.3) and the persistency study (Section 3.5) is based on data on earthquake zones, provided by the United

[36] Throughout, only districts with more than 10 respondents in each year are included in the estimations. This means dropping 9 districts in the main regressions of Table 2. Including the full set of districts does not alter the results, neither does restricting the required number of respondents further, and neither does weighting the results with the number of respondents, see Appendix B.2.

Nations Environmental Programme as part of the Global Resource Information Database (UNEP/GRID) and depicted in Figure 1.[37,38] Earthquake risk is divided into 5 categories, 0-4, based on various parameters such as ground acceleration, duration of earthquakes, subsoil effects, and historical earthquake reports. The intensity is measured on the Modified Mercalli (MM) Scale and the zones indicate the probability that an earthquake of a certain size hits within the next 50 years. Zone zero indicates earthquakes of size Moderate or less (V or below on the MM Scale), zone one indicates Strong earthquakes (VI on the MM Scale), zone two indicates Very Strong (VII), three indicates Severe (VIII), zone four indicates that a Violent or Extreme earthquake will hit (IX or X).

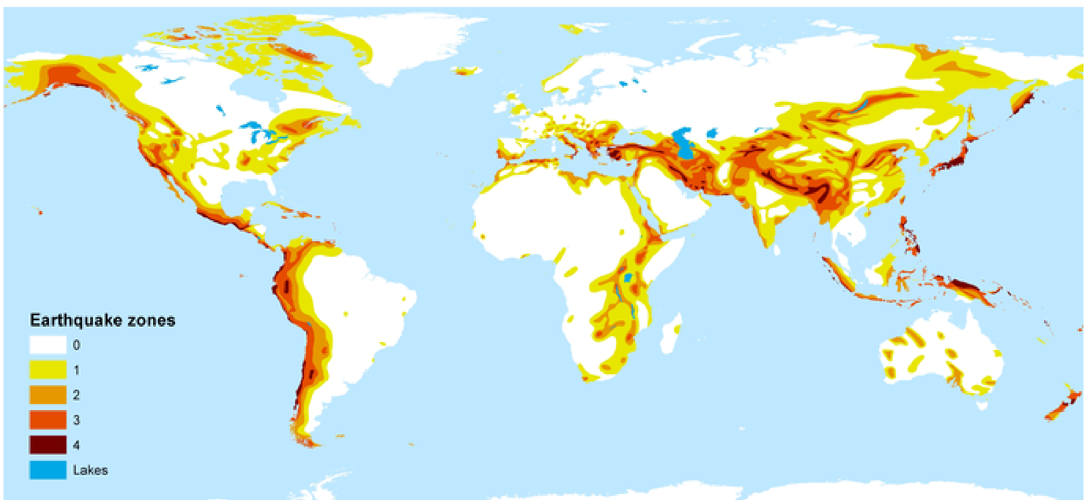


Figure 1. Earthquake zones

Notes. Darker color indicates higher earthquake risk. Zones described in the text. Source: UNEP/GRID

To calculate earthquake risk for subnational regions of the World, I use ArcGIS software combining the shapefile of first administrative units from ESRI.com with the raster data pictured in Figure 1. I construct the variable $dist(earthquakes)_{dc}$ as the geodesic distance from the centroid of subnational district d located in country c to the closest high-intensity earthquake zone, where the choice of "high-intensity" is a balance between choosing zones that are represented in as many parts of the World as possible and choosing zones where the particular level of earthquake risk is high enough to potentially matter for peoples' lives. Appendix B.3 shows that the main results (of Table 2 below) hold for all choices of zones:

[37] Data available online at http://geodata.grid.unep.ch/.

[38] Data on, e.g., losses from natural disasters is inappropriate for the current analysis, as losses are highly endogenous to economic development, which in itself might correlate with religiosity.

distance to zones 1-4, zones 2-4, zones 3-4, and zone 4 only. The appendix shows that the relationship between religiosity and $dist(earthquakes)$ increases in size when adding more zones, but as expected the precision also diminishes. In an attempt to maximize precision and relevance at the same time, I define the two top earthquake zones (3 and 4) as "high intensity" zones in the main results. That is, $dist(earthquakes)_{dc}$ measures the distance from the district centroid to zones 3 or 4 (dark red and dark orange on the map).

Another measure of earthquake risk is the average earthquake zone value in a district, $mean(earthquake)_{dc}$. The correlation between $mean(earthquake)$ and $dist(earthquakes)$ is high: -0.65, and Appendix B.3 documents that the main conclusion is unaltered when using this measure instead. However, $dist(earthquakes)$ wins the horse race between the two when included simultaneously in the main regression on religiosity. The superiority of the distance measure is a priori to be expected, as some information is lost when using the mean measure: According to the $mean(earthquake)_{dc}$ measure, a district located entirely in earthquake zone zero, but neighboring a district that is hit frequently by earthquakes, will obtain the same earthquake risk score as another district in zone zero located, say, 2000 km from the nearest high-intensity earthquake zone. The inhabitants of the former are obviously more aware of earthquakes and perhaps even have family members in high-frequency zones, while earthquakes probably play no role in the lives of the inhabitants of the district located 2000 km away from any high earthquake risk zones. Therefore, the distance measure provides a more accurate measure of the presence of the stress caused by earthquakes in peoples' lives compared to an average measure.

Another benefit from calculating distances is that various disaster measures can be more easily compared. For instance, the earthquake, storm and volcano risk data are based on zones, while the tsunami data are based on instances of tsunamis. It is not clear how to construct a mean measure for the latter. While the main disaster frequency measure is based on earthquakes, additional disasters are investigated in Table 3.

Based on the distance measure, the region with the lowest earthquake risk in the sample is the region of Paraíba, a region on the Eastern tip of Brazil, located 3,355 km from the nearest high-intensity earthquake zone (which is the earthquake zone located on the West coast of South America). Many regions obtain an earthquake distance of zero as they are located within earthquake zones 3 or 4.[39] Examples are Sofia in Bulgaria, the Kanto region

[39] For robustness, Appendix B.6 excludes the zeroes with no change to the results, indicating that the estimated effect of earthquakes on religiosity can be interpreted as the impact of earthquakes on units that are located close to an earthquake zone, but are not necessarily devastated by earthquakes.

of Japan, and Jawa Tengah in Indonesia. The mean (median) distance to earthquake zones 3 or 4 is 441 (260) km.

3.3 Cross-districts study

In order to test whether individuals are more religious when living in areas hit more frequently by earthquakes, I estimate equations of the form:[40]

$$religiosity_{idct} = \alpha + \beta earthquakerisk_{dc} + \gamma_c + \lambda_t + X'_{dct}\eta + W'_{idct}\delta + \varepsilon_{idct}, \quad (1)$$

where $religiosity_{idct}$ is the level of religiosity of individual i interviewed in subnational district d within country c at time t, $earthquakerisk_{dc}$ is earthquake frequency in district d of country c. γ_c measures country-fixed effects and thus removes variation in nationwide factors (e.g., some dimensions of culture and institutions). λ_t measures year of interview fixed effects. W_{idct} is a vector of relevant controls at the individual level: age, age squared, sex, marital status, education, income.

X_{dct} captures observable district-level confounders: dummies to weed out the short term effects of actual earthquakes, distance to the ocean, and other geographic confounders potentially related to earthquakes, described below. Additional controls are added in Appendix B.6.

Appendix B.7 shows that the results are robust to other functional forms, such as including a squared term of earthquake distance, using instead (1+) the logarithm of the earthquake distance, etc.

Viewed in isolation, we cannot rule out that the estimate of β includes omitted confounders, which is the reason for moving on to the event study in the next section.

Table 2 shows the results from estimating equation (1) across 105,947 individuals from 591 subnational districts of the World, using distance to nearest high intensity earthquake zone, $dist(earthquakes)$, as the measure of earthquake risk. The religiosity measure in Table 2 is the Strength of Religiosity Scale, but Appendix B.9 shows that the results hold for each of the different components of the Strength of Religiosity Scale.[41] The first column shows the simple relation between religiosity and distance to earthquakes. The estimate on earthquake

[40] I use the appropriate weights provided by the pooled WVS/EVS (original country weights, variable s017). The estimates are very similar when not using weights.

[41] Furthermore, one particular component of the Strength of Religiosity Scale with the most answers, namely answers to the question "How important is God in your life?" is included in most other robustness checks in addition to the Strength of Religiosity Scale.

distance is highly significant and of the expected sign: individuals living in districts that are located closer to an earthquake zone, are more religious.

One may worry that natural disasters correlate with countrywide factors, such as geography or some dimensions of culture and institutions, that also have a bearing on religiosity. To accommodate this, column (2) includes country fixed effects. The estimate on earthquake-distance drops by only a quarter, indicating that the main impact from earthquakes on religiosity seems to work within countries. The sample includes interviews of individuals surveyed in 19 different years between 1981 and 2009. While the earthquake measure in this section does not vary over time, it could still be the case that the timing of the measure of religiosity biases the results. Column (3) adds time-fixed effects with no change to the results.

Column (4) adds individual-level standard controls for sex, marital status, age, and age squared. The estimate on earthquake distance drops slightly in absolute size, but not significantly.

Column (5) includes district-level geographic controls to account for various concerns. First, one may worry that the impact of $earthquakerisk_{dc}$ captures a short term effect of actual earthquakes that hit the district recently, or, on the contrary, the long-term impact could be contaminated by recent earthquakes.[42] Therefore, column (5) adds a dummy equal to one if an earthquake hit in the current year of interview and a dummy equal to one if an earthquake hit in the year before the interview.[43] Second, since large parts of the severe earthquake zones are located close to the ocean, one may worry that $\hat{\beta}$ is contaminated by some correlation between distance to the ocean and religiosity. Therefore, distance to the ocean is added to the list of controls in column (5). Third, larger districts may be hit by more earthquakes, which is the reason for including a control for district area. Last, absolute latitude is added as a "catch-all" geographic measure. The estimate on distance to nearest earthquake zone is unaltered when including these controls.

[42] Corroborating this, Appendix B.5 shows that the impact of long term earthquake risk is reduced when a recent earthquake hit.

[43] The data on actual earthquake events is described in Section 3.4.1. Appendix B.5 shows that adding more lags does not change the results.

Table 2. OLS of religiosity on long-term earthquake risk

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: Strength of Religiosity Scale [0;1]						
Dist(earthq), 1000km	-0.094***	-0.070***	-0.071***	-0.066***	-0.061***	-0.056***
	(0.023)	(0.017)	(0.017)	(0.017)	(0.016)	(0.015)
	[0.053]	[0.019]	[0.019]	[0.020]	[0.015]	[0.014]
Observations	105,947	105,947	105,947	103,283	103,281	66,112
R-squared	0.021	0.294	0.299	0.331	0.332	0.311
Country FE	N	Y	Y	Y	Y	Y
Year FE	N	N	Y	Y	Y	Y
Indl controls	N	N	N	Y	Y	Y
Geo controls	N	N	N	N	Y	Y
Inc and edu FE	N	N	N	N	N	Y
Districts	591	591	591	591	591	458
Countries	66	66	66	66	66	52

Notes. OLS estimates. The unit of analysis is an individual. The dependent variable is Inglehart's Strength of Religiosity Scale [0,1], which is an average (principal components analysis) of answers to six questions on religiosity, depicted in Table 1. Dist(earthquake) measures the distance in 1000s of km from the district centroid to the nearest high-intensity earthquake-zone (zones 3 or 4), depicted in Figure 1. Country FE indicates country fixed effects, time FE indicates year of interview fixed effects. Indl controls indicates controls for respondent's age, age squared, sex, and marital status. Geo controls indicates subnational district level controls for absolute latitude, distance to the coast, district area, and earthquake dummies for whether an earthquake hit in the year of interview or the year before. Inc and edu FE indicates 10 income dummies and 8 education dummies. Districts indicates the number of subnational districts in the sample. Likewise, countries refers to the number of countries. The standard deviations are clustered at the level of subnational districts in parenthesis and at the country-level in squared brackets. All columns include a constant. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level, respectively.

According to the modernization hypothesis (e.g., Inglehart & Baker (2000)), income and education levels may influence an individual's degree of believing, which poses a potential problem if earthquakes influence income and education levels. So far, the literature has been inconclusive as to the effect of earthquakes on economic outcomes (see e.g., Ahlerup (2013) for a positive effect, Cavallo *et al.* (2013) for a negative impact), perhaps because earthquakes have local effects that cancel each other out (e.g., Fisker (2012)). Nevertheless, to account for this, column (6) adds dummies indicating individuals' education and income levels based on the ordered categorical variables constructed by the WVS and EVS; income is measured in 1-10 deciles, while education ranges from 1-8, where 1 indicates "Inadequately completed elementary education" and 8 indicates "University with degree / Higher education".[44] Obviously, education and income are potentially endogenous to religiosity; 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). Thus, the result in column (6) should be interpreted with caution.[45]

The distance to nearest earthquake zone ranges from 0 to 3,355 km. Even if the religious coping hypothesis was true, we do not expect that regions located 3,000 km from an earthquake zone are significantly more religious than regions located 3,100 km away. Both of these districts are located so far away from earthquake zones that 100 km should not matter much. In other words, the effect is probably not perfectly linear. Appendix B.7 confirms that the effect of earthquakes is stronger, when excluding districts located more than 1500, 1000, and 500 km away, or more formally; the squared term is significant and positive. Appendix B.7 also shows binned scatterplots where the distance to nearest high-risk earthquake zone is divided into 50 equally-sized bins, revealing that the relationship between earthquake distance and religiosity is stronger among districts located closer to the high-risk zones.

The main estimated standard deviations in Table 2 are clustered at the subnational district level to account for potential spatial dependence. Clustering at the country-level produces the same conclusions, shown in squared brackets. Another, more conservative, way to account for spatial dependence at the district (country) level is to average religiosity across districts (countries). The added variable plots in Figure 3 correspond to column (5) of Table 2, aggregated to the subnational district (country) level in the left (right) panel.[46] Whichever method is used, the estimate remains significantly different from zero.

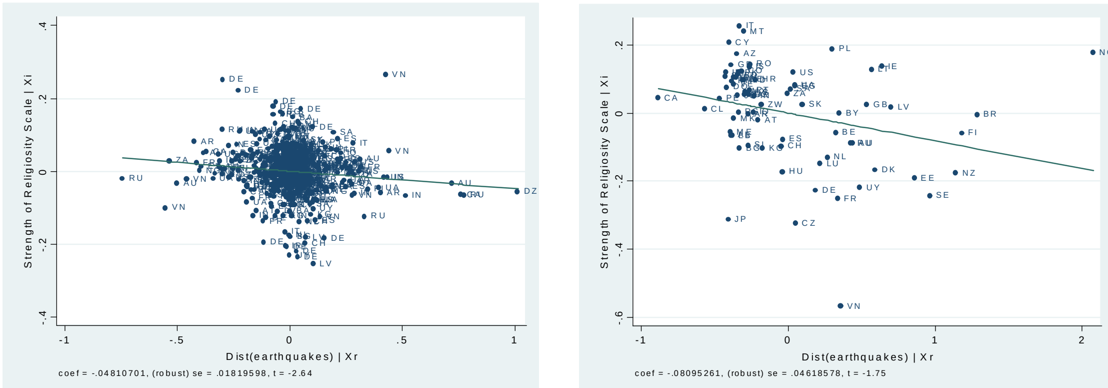
The Added Variable Plot further confirms that the result does not seem to be driven by individual observations. Furthermore, the cross-country estimates in the right panel also serve as an out-of-sample check of the results, since the country-level aggregates are independent of the information on subnational districts (which is only available for a subsample). This means increasing the number of countries included from 66 to 75.[47]

[44] The estimate of interest is unchanged if the two categorical variables were included directly instead of the 18 dummy variables.

[45] Appendix B.6 includes additional measures of development; lights visible from space, population density, and share of arable land. The results are unchanged.

[46] The individual level confounders are controlled for before collapsing the residuals to the regional (country) level and the remaining confounders are accounted for in the aggregated sample. District level results for all columns of Table 2 are shown in a previous version of the paper, confirming the results.

[47] Using instead the religiosity measure "Importance of God" (AV plots in Appendix B.8) increases the number of districts to 884 and the number of countries to 100. The country-aggregates here include the recent WVS wave, which has information on "Importance of God". The plots are very similar.



District aggregates Country aggregates

Figure 3. Added variable plots of religiosity on earthquake frequency

Notes. AV-plots of OLS estimation across district-level aggregates in the left panel and country level aggregates in the right panel. The dependent variable is the Strength of Religiosity Scale. Included controls correspond to those used in column (5) of Table 2, where the individual-level controls are accounted for before aggregation. Labels: Country ISO codes.

The AV-plots reveal that the impact of earthquake risk on religiosity seems to be a global phenomenon. To further investigate this, Appendix B.10 interacts earthquake risk with a dummy for each of the large religious denominations; Protestantism, Catholicism, Islam, Hinduism, and Buddhism in Table A10 and with a dummy for each continent in Table A11. Adherents to all religions engage in religious coping, although some engage a bit less (Catholics and Buddhists), others more (Protestants).[48] Furthermore, the continent on which the individuals live does not matter for the degree of religious coping. This confirms testable implication 2.

Getting at the size of the effect, taking the preferred estimate in column (5) at face value, individuals living in districts located 1000 km closer to a disaster-zone tend to be 6 percentage points more religious. In other words, reducing earthquake risk by 1.5 standard deviations reduces religiosity by 0.4 standard deviations. The difference in religiosity amounts to reducing the religiosity in the Alentejo district in Southern Portugal (median religiosity) to the Hessen district of central Germany.[49] These districts are located 1500 km apart.

[48] The finding that Protestants use religion in coping more than Catholics is consistent with the idea that Catholicism is a much more community-based religion, while Calvin's doctrine of salvation is based on the principle of "faith alone" (Weber (1930), p.117). This gives the Catholics an additional alternative to intensified believing, namely their networks. There are not enough Buddhists and Hindus in the sample to properly test for their differential religious coping strategies.

[49] These examples are calculated in the sample where the observations are aggregated to the district level after filtering out the confounders in column (5).

3.3.1 Further robustness tests

Additional controls (trust, population density, light density at night, arable land shares, average temperature, average and variance of precipitation, and a dummy equal to one if the district is located within zones 3 or 4) are included in Appendix B.6 with no change to the results. Indeed, the estimate of interest stays remarkably constant throughout. In fact, the variable resulting in the largest reduction in the estimate of earthquake distance on religiosity is arable land (which is insignificant), which reduces $\hat{\beta}$ from 0.061 to 0.058. If any omitted variable should reduce $\hat{\beta}$ to zero, it should result in a twenty times larger reduction compared to the reduction caused by arable land.

Appendix B.6 also excludes the districts located within zones 3 or 4 with no change to the results. This exercise makes sure that the results are not driven by the difference between the districts located in zones 3 and 4 and the rest. The finding also rules out the idea that a certain type of individuals evolved in high-risk earthquake areas and that it is this specific type of people who respond to earthquakes.

The results are robust to using the individual measures of religiosity entering the Strength of Religiosity measure one by one, shown in Appendix B.9. All six measures are significantly higher in districts located near high-risk earthquake zones. In fact, the impact on answers to the question "Do you believe in an Afterlife?" is twice the size of the impact shown in Table 2. The two least affected questions are "Do you believe in God?" and "How often do you attend church?". The former seems to be a more fundamental part of religiosity, not affected by adverse life events. The latter is consistent with the literature on religious coping, which also finds that churchgoing is less affected than believing, thus confirming testable implication 3.[50] If the main explanation for the results was physical insurance, we would have expected church attendance to be the most affected religiosity measure. The exercise also serves as an increase in the sample size. Answers to the question "How important is God in your life?" is available for individuals from 884 districts, spanning 85 countries, compared to the 591 districts in Table 2. The impact is unaltered on this much larger sample.

Regarding individual differences, the degree of religious coping does not seem to vary with income; the interactions between earthquake risk and personal income (Appendix B.13) or district-wide income levels measured by visible lights (Appendix B.6) are insignificant. This

[50] The result of a small effect on church attendance is unaltered if one instead used a church attendance dummy equal to one if the person goes to church once a month or more often (this dummy splits the sample in two equally sized groups) (results available upon request).

finding seems at odds with religion as physical insurance; if religion serves as a provider of material means, then religion should be used mainly by those with fewer means. Viewed in isolation, this finding is also at odds with some studies in the religious coping literature (e.g., Gurin *et al.* (1960)), but consistent with others (e.g., Carl Pieper *et al.* (1992)). On the other hand, I find that less educated, unemployed, and unmarried individuals engage more in religious coping, also, for the two former, after controlling for income. These results are consistent with studies by e.g., Clark & Lelkes (2005) who finds that the religious experience less psychological harm from unemployment and divorce.[51] It is also consistent with the idea that education, in addition to providing potentially higher income, provides knowledge (about tectonic plates in particular) and social networks. Likewise, being unemployed not only means lower incomes, but also loneliness, reducing the set of social coping alternatives. If religion played only a physical insurance role, we would not expect education and employment to play a role after controlling for income.

So far, the results could be driven by selection; the idea that atheists move out of earthquake areas, while the religious are more likely to see the earthquakes as a consequence of their own actions, thus making moving less of a solution. While this concern is dealt with in the event study in Section 3.4, the following is a check of the cross-section results. If the results were driven by migration, we would expect the effect to be smaller across larger districts, where it is less likely that moving away from the earthquake area means moving out of the district. Appendix Table A7, column (12) shows that this does not seem to be the case; the impact of earthquakes does not depend on the size of the districts.

3.3.2 Alternative types of natural disasters

The literature on religious coping states that unforeseeable life events are more likely to instigate religious coping compared to more foreseeable events. Accordingly, we expect that people use their religion to cope with unforeseeable disasters, such as earthquakes, tsunamis, and volcanoes, to a larger extent than more foreseeable disasters, such as seasonal storms.

Table 3 shows the impact on religiosity of distance to earthquakes, tsunamis, volcanoes, and tropical storms.[52] All columns include the full set of exogenous baseline con-

[51] See also review by Pargament (2001) of studies finding differential degrees of religious across individuals with fewer alternatives.

[52] The types of disasters are chosen based on the Munich Re map, which shows the worst types of disasters across the globe. The correlation between distance to earthquake zones and the other measures are: 0.457 (volcanoes), 0.381 (tsunamis), and 0.196 (storms), respectively. All disasters are described in Appendix B.11.

trols from column (5) of Table 2. Column (1) reproduces the regression using earthquakes. Tsunamis are included in column (2), exerting virtually the same impact on religiosity as earthquakes. Column (3) includes the average distance to earthquakes and tsunamis: $\frac{distance(earthquakes)+distance(tsunamis)}{2}$, whereas column (4) includes the minimum distance to either of the two: $min(distance(earthquakes), distance(tsunamis))$. As expected, people are affected more if they live in an area hit by both tsunamis and earthquakes, compared to an area hit by only one of the two.

In column (5), the disaster measure is distance to volcanoes. While the sign of the estimate is still negative, it is not significantly different from zero. It seems that volcanic eruptions simply hit too few districts of the World in order to have an impact: The size of the estimate increases nearly fivefold when zooming in on districts located within 1000 km of a volcanic eruption zone, becoming statistically different from zero.

A rather foreseeable type of disaster is tropical storms, which happen at the same time of year every year, is used in columns (7) and (8). In accordance with the religious coping hypothesis, the impact of storms on religiosity is indistinguishable from zero and unchanged after zooming in on districts located within 1000 km of a storm zone. Appendix B.12 shows that this finding is not because storms are less severe than earthquakes; over time, storms and earthquakes alike have resulted in a similar number of deaths, a similar number of people affected and a similar amount of economic damage. This again indicates that physical insurance is not the main explanation for the results; in that case, we would have expected storms to have the same impact on religiosity as the remaining disasters.

Table 3. Varying disaster measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable: Strength of Religiosity Scale								
dist(disaster)	-0.061***	-0.058***	-0.086***	-0.076***	-0.008	-0.036***	-0.020	0.015
	(0.016)	(0.016)	(0.020)	(0.019)	(0.007)	(0.013)	(0.013)	(0.027)
Observations	103,281	103,281	103,281	103,281	103,281	58,567	103,281	38,568
R-squared	0.332	0.332	0.333	0.333	0.332	0.329	0.332	0.337
Disaster	Earthq	Tsunami	Avg	Min	Volcano	Volcano	Storm	Storm
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y
Sample	Full	Full	Full	Full	Full	<1000 km	Full	<1000 km
Districts	591	591	591	591	591	321	591	129

Notes. OLS estimates. The unit of analysis is an individual. The dependent variable is the Strength of Religiosity Scale [0,1]. The disaster measure is distance from district centroid to earthquake zones 3 or 4 in column (1), distance to tsunamis in column (2), the average distance to earthquake zones and tsunamis in column (3), the minimum distance to either earthquake zones or tsunamis in column (4), distance to volcano zones in columns (5) and (6), and distance to tropical storm zones in column (7) and (8). Baseline controls include all controls from column (5) of Table 2. All columns include a constant. standard deviations (in parenthesis) are clustered at the level of subnational districts. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level, respectively.

The results are consistent with testable implication 5: Religion is used to a larger extent as a response to unpredictable disasters as opposed to predictable disasters.

3.4 Identification: Event study

The results so far may be biased by unobservables. This section attempts to deal with this by estimating whether district-level religiosity changes when the district is hit by an earthquake. The same individuals are not observed at different points in time in the pooled WVS-EVS. But a third of the subnational districts are measured more than once, which makes it possible to construct a so-called synthetic panel, where the panel dimension is the subnational district and the time dimension is the year of interview.[53]

For each year of interview, I first aggregate religiosity to the district level in equation (1), let earthquake instances vary over time, and allow for country-by-year fixed effects:

$$religiosity^W_{dct} = \alpha + \beta earthquakes_{dct} + \lambda_{ct} + \gamma_d + X'_{dct}\eta + \varepsilon_{dct}, \tag{2}$$

where $religiosity^W_{dct}$ measures religiosity in district d measured in wave t.[54] W indicates whether the standard individual-level controls are accounted for before aggregating the data: sex, marital status, age, age squared, 10 income dummies, and 8 education dummies.[55] $earthquakes_{dct}$ measures the number of earthquakes that hit the district at time t. As the analysis will take out district-fixed effects, the results are unchanged if $earthquakes_{dct}$ instead measured the number of earthquakes that ever hit the district before time t.

[53] 339 districts out of the 887 total districts were surveyed more than once. Restricting the sample of column (5) Table 2 to the sample, where districts were surveyed more than once does not alter the estimate on earthquake risk: -0.067 (se 0.018).

[54] $religiosity_{dct}$ is based on information at the individual level aggregated up to the district level, using appropriate weights, w_{idct}: $religiosity_{dct} = \frac{1}{N}\sum_{i=1}^{N} w_{idct} \cdot religiosity_{idct}$. The weights are the same weights as those used in the cross-district analysis above (variable s017 in the pooled WVS-EVS).

[55] In these cases, $religiosity^W_{dct}$ is the district-level aggregate of the residuals of a regression of $religiosity_{idct}$ on sex, marital status, age, age squared, 10 income dummies, and 8 education dummies. Another way to account for the individual level controls would be to first aggregate them to the district-level and include them in equation (3), but this would mean throwing away information.

To account for district-level fixed effects, I then take first differences arriving at the main equation to estimate:

$$\Delta religiosity^{W}_{dct} = \alpha + \beta \Delta earthquakes_{dct} + \lambda_{ct} + \Delta X'_{dct}\delta + \Delta\varepsilon_{dct}, \tag{3}$$

where $\Delta religiosity^{W}_{dct} = religiosity^{W}_{dct} - religiosity^{W}_{dct-1}$ measures the change in religiosity between waves t-1 and t in district d.

$\Delta earthquakes_{dct} = earthquakes_{dct} - earthquakes_{dct-1}$ measures the number of earthquakes that hit in between interview waves $t-1$ and wave t. The main measure is a dummy equal to one if one or more earthquakes hit in between the waves. The results are robust to using instead the actual number of earthquakes that hit in between the waves, shown in Appendix C.5.

λ_{ct} are country-by-year fixed effects, removing everything at the country-level that changes over time.[56] Furthermore, since we are looking at first differences, everything at the district level which does not change over time (such as geographic characteristics, some cultural attributes, and some institutions) is accounted for.

$\Delta X'_{dct}$ includes two main district-level controls that change over time. First, the panel is highly unbalanced. For instance, the districts of Albania are interviewed in year 1998 and year 2002, while the districts of Australia are measured in year 1995 and year 2005. If religiosity reverts back to the long term level when stress relief has been obtained, we would expect that the impact of an earthquake on religiosity in societies like Albania with a shorter window of observation to be higher than the impact for societies like Australia with a longer window of observation. For this reason, period length is controlled for. Second, along the same line of reasoning, we would expect that an earthquake that hit 10 years ago would exert a smaller impact on current religiosity levels compared to an earthquake that hit last year. For this reason, I include a control for the number of years since an earthquake hit the district. For districts that did not experience an earthquake since 1973, I code this variable to 100.[57] The results are robust to excluding these controls.

The dynamics of the impact of earthquakes is analyzed in Appendix C.3, exploiting the different period lengths and years since the last earthquake.

The parameter of interest is β, which measures the difference in religiosity between dis-

[56] Results are unaltered if country and time fixed effects are included separately instead.

[57] Restricting the sample to the districts that were hit by an earthquake at some point in time since 1973 reduces the sample to 113 district-years. The results are unaltered on this sample. If anything, the parameter estimate on earthquakes increases.

tricts that experienced one or more earthquakes in between interviews and those that did not. The religious coping theory suggests that $\beta > 0$: religiosity is higher in districts that experienced one or more earthquakes compared to those that did not.

An alternative model could include lagged religiosity, which does not alter the results. Also, instead of taking first differences, one could include district-fixed effects in equation (2), which produces very similar results. See Appendix C.2 for these alternative models.[58]

3.4.1 Data on earthquake events

The Advanced National Seismic System (ANSS) at the US Geological Survey (USGS) provides data on the timing, location, and severity of all earthquakes that happened since the year 1898.[59] Due to improvements in earthquake-detection technology, earthquakes of magnitudes below 5 cannot be compared over time, and neither can earthquakes before 1973.[60] The analysis exploits the 68,711 earthquakes that hit the globe's surface between 1973 and 2014 of a magnitude of 5 or above.[61] These earthquakes are depicted in Figure 2, which divides the earthquakes into two categories; those of magnitude 5-5,999 (dark blue dot) and those of magnitude 6 or above (larger red dot).

I construct a measure of earthquake events for each subnational district in two steps. First, for each of the subnational districts I calculate the distance to the nearest 100 earthquakes.[62] I do this for every year from 1973 to 2014. I then define a district as being hit

[58] The same table also includes the interaction between the initial level of religiosity and the earthquake dummy. The interaction is insignificant, which can mean two things; the district-level of religiosity does not matter for the degree to which people use their religion in coping (note that these results are based on district aggregates, not individuals) or more mechanically, that religiosity cannot increase as much in districts where religiosity is already high.

[59] Specifically, the earthquakes are downloadable from the Comprehensive Earthquake Catalogue, available online from http://earthquake.usgs.gov/monitoring/anss/

[60] For each earthquake, the U.S. Geological Survey provides the best available estimate of the earthquake's magnitude. Magnitudes can be measured in many different ways because each method only works over a limited range of magnitudes and with different types of seismometers. Some methods are based on body waves (which travel deep within the structure of the earth) and some are based on surface waves (which primarily travel along the uppermost layers of the earth). However, all of the methods are designed to agree well over the range of magnitudes where they are reliable. Earthquake magnitude is a logarithmic measure of earthquake size, which means that the shaking will be 10 times as large during a magnitude 6 earthquake as during a magnitude 5 earthquake. The total amount of energy released by the earthquake, however, goes up by a factor of 32.

[61] Compared to the earthquake measure in the cross-district analysis, earthquake zones 3-4 correspond to above 6.0 on the Richter scale. As the cross-district analysis uses the distance to these zones, it implicitly also includes the smaller earthquakes as we move further away from the high-risk zones. Note that the earthquakes in the event study are measured in terms of magnitude, which includes the Richter Scale, but also other comparable scales. As the analysis will show, earthquakes of magnitudes of 6 or above have the largest impact on religiosity, in line with the cross-district analysis.

[62] The shapefile used for the subnational districts is from ESRI and is the same as in the cross-district

by an earthquake if the earthquake hit within X km of the district borders. I choose X low enough to ensure that the earthquake was likely to influence the people in the particular district, even in the short run, but high enough to ensure that I do not lose potentially influential earthquakes. The earthquake measure used in the main analysis uses a cutoff of 100 km. Hence, when an earthquake hit within 100 km of the district borders, I define the district as being hit by an earthquake. The results are robust to alternative cutoff levels (see Appendix C.1).[63]

The main earthquake variable is a dummy variable equal to one if one or more earthquakes hit in between waves, zero otherwise. The three districts in the sample that experienced the largest number of earthquakes of magnitude 5 or above per year were Russian Far East (25.6 earthquakes of magnitude 5 or above per year), Mindanao in the Philippines (24 earthquakes per year), and Hokkaido Tohoku in Japan (18.7 earthquakes per year). The same three districts were also among the top-four experiencing earthquakes of magnitude 6 or above per year (3.4, 1.8, and 1.9, respectively). The South of Mexico enters the top-4 with 2.8 earthquakes of magnitude 6 or above per year.

An alternative measure is the actual number of earthquakes, which is shown in Appendix Table C.5. The reason for not using the continuous measure from the cross-district analysis is that I need a way to split up the districts into those that were hit by an earthquake and those that were not. The continuous measure is used in an interaction term in Appendix C.7.

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analysis.

[63] 49,194 earthquakes of magnitude 5 or above hit within a distance of 100 km from the ESRI shapefile of subnational districts.

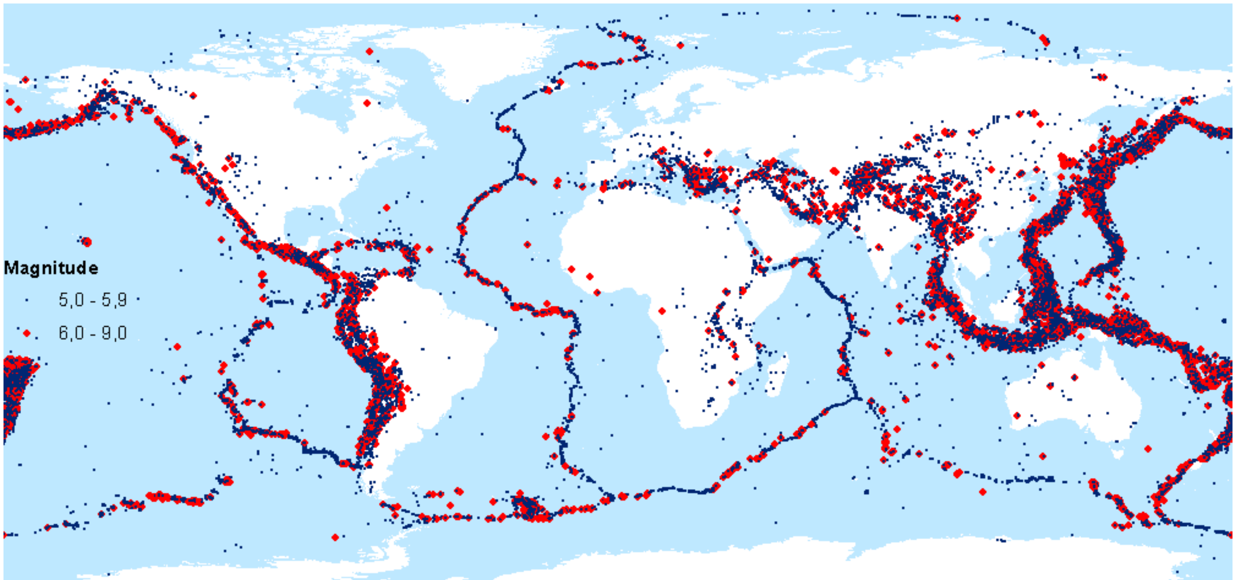

Figure 2. Earthquake events 1973-2014 of magnitude 5 or above

Notes. Map of subnational districts from the pooled WVS/EVS 1981-2009 and the epicenter of all earthquake events of a magnitude of 6 or above that occured over the period 1973-2014. Dark green districts are measured more than once in the WVS-EVS, while light green indicates that the district is measured once. Source for earthquake data: USGS.

The World Values Survey and European Values Study only provide information on the year (as opposed to month) of the interview for the majority of the sample, thus it is not possible to distinguish whether an earthquake striking in the year of the interview hit before or after the interview.[64] I therefore drop observations where an earthquake hit in the same year as the WVS interview. This means dropping 38 observations in the main regressions. Dropping these observations also means dropping the districts that are most often hit by earthquakes, including the four extremes described above. The results are qualitatively robust to including the particular observations.

3.4.2 Data on religiosity

As in the previous analysis, the results are shown for both the Strength of Religiosity Scale, the "Importance of God" measure, and the remaining measures of religiosity in the Appendix. I put most emphasis on the results using the "Importance of God" measure for several reasons. The main purpose of the cross-district analysis was to investigate the *global extent* of the impact, which speaks for the composite measure in order to catch all types of religiosity

[64] The WVS provides information on the month of the interview for a third of the sample. Hence, if I calculated instead the distance to the nearest earthquake in each month of each year, I could gain a maximum of 12 observations (a third times the 38 observations where an earthquake hit in the interview year), provided that none of the earthquakes hit in the same month as the interview.

across the globe. The purpose of this analysis is instead to pin down the mechanism, which speaks for focusing the analysis on intrinsic religiosity, as results including church going could be caused by the physical insurance mechanism. Further, the "Importance of God" measure has the most observations of all the religiosity measures, which is important in this much reduced sample, which encompasses only a third of the previous sample. For this reason, I choose to have results for "Importance of God" in the main text and relegate results using the Strength of Religiosity Scale to the Appendix. The results using Strength of Religiosity Scale are all significant at conventional levels, shown in Appendix C.4, which also shows the results for the remaining religiosity measures.

3.4.3 Summary statistics

The panel is highly unbalanced. The number of years with data on "Importance of God" per district ranges from 2 to 5 years (on average 2.5 years). With 288 districts in total, this generates a total of 420 district-year events. The number of years in between interviews varies between 1 and 17 years across districts (on average 6.4 years). The most frequent number of years in between districts is 5 years.

Of the 288 districts with more than one year of answers to the "Importance of God" question, 127 were hit by one or more earthquakes of magnitude 5 or above (3497 earthquakes in total across the globe), 35 were hit by one or more earthquakes of magnitude 6 or above (340 earthquakes in total). The information on magnitudes allows for a consistency check: Does religiosity respond to larger or smaller earthquakes? Appendix C.6 shows that the impact of earthquakes increases between magnitudes 5 and 6, and starts to drop again when including only earthquakes of magnitude 6.5 or above. The latter only includes 20 earthquakes in total, though. To maximize the impact of the earthquakes and at the same time maximize the number of earthquakes included in the analysis, I choose magnitudes of 6 or above as the cutoff in the main analysis.

Table 4 shows the summary statistics for the main variables (the earthquake variables are for earthquakes of magnitudes 6 or above).

Table 4. Summary statistics of the main variables for event study for magnitude>=6

Measure	N	Mean	std.dev	Min	Max
$religiosity$	766	0.686	0.225	0.028	1.000
$\Delta religiosity$	458	0.017	0.119	-0.565	0.481
$\Delta earthquake$	458	0.742	2.949	0	38
Earthquake dummy	458	0.175	0.380	0	1
λ_t	766	2001.3	6.110	1981	2009
$\Delta\lambda_t$	458	6.382	3.328	1	17

Notes. The unit of observation is a subnational district at time t. The religiosity measure is the district average of answers to the question "How important is God in your life?" (categorical variable with 10 possible answers from 0="not at all important" to 1="very important").

3.4.4 Analysis

As an introductory exercise, Figure 4 splits the sample in two: the district-years with one or more earthquakes and those without. An important determinant of both earthquakes and change in religiosity is the number of years in between the two waves in question. To eliminate this bias, the main analysis includes a control for the period lengths, but as an introductory exercise, the figure shows only the districts that are measured with a 5 year gap. The figure shows that religiosity increased by 5.0 percentage points across periods in the 11 districts that were hit by an earthquake compared to a fall of 1.8 percentage points in the 81 districts that were not shaken by earthquakes.[65] The difference between the two averages is only just above half a standard deviation, though, and more formal analysis is necessary to investigate whether the difference is statistically different from zero.

[65] A similar figure emerges when only restricting to districts with 3-10 year gaps. This gives 39 districts that were hit by earthquakes, and 267 that were not. Using instead the Strength of Religiosity Scale in Figure 4, the 4 districts that were hit by one or more earthquakes experienced no change in religiosity over the period (mean = 0.0003), while the 37 districts that were not hit by an earthquake over the period, experienced a fall in religiosity of 1.1 percentage points.

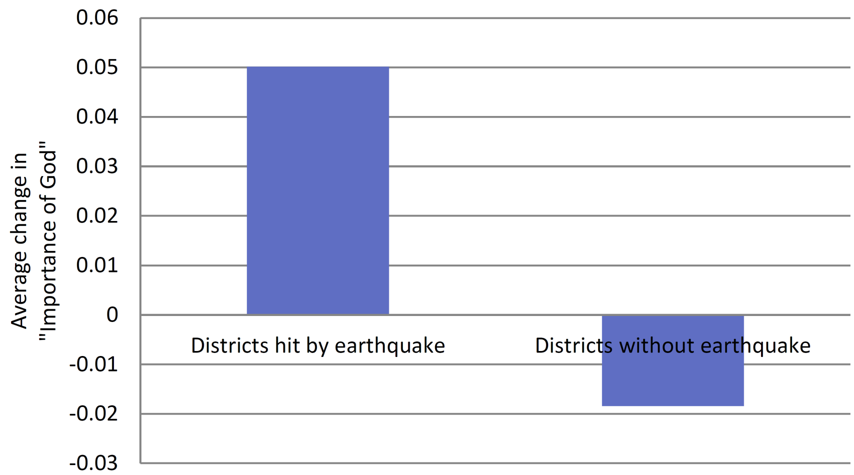

Figure 4. Change in religiosity by earthquake or not

Notes. The sample is restricted to districts where the interviews took place 5 years apart. Districts are split into the 11 districts that experienced an earthquake in between the survey years, and the 81 that did not.

Table 5, panel A presents the results from estimating equation (3) using "Importance of God" as the measure of religiosity.[66] The table is reproduced in Appendix C.4 using the Strength of Religiosity Scale reaching the same conclusions. Column (1) shows the simple difference in religiosity between districts that were hit by an earthquake and those that were not, controlling only for country-by-year fixed effects. In line with the religious coping hypothesis, religiosity increased more in districts that were hit by an earthquake, compared to those that were not. Column (2) adds a control for the number of years in between the interview years and a control for the number of years since the last earthquake, set to 100 if no earthquake hit since 1973. The difference in religiosity between districts hit by an earthquake and those that were not is statistically unaltered, if anything it increases. Column (3) adds individual level controls and column (4) further adds income and education dummies. The difference in religiosity between districts hit by earthquakes and those not, is unaltered and significant at the 1% level.

[66] Standard errors are clustered at the country-level throughout. Conclusions are unaltered if using instead unclustered standard errors.

Table 5. First-difference estimation of earthquakes on religiosity

	(1)	(2)	(3)	(4)
Dependent variable: Change in "Importance of God"				
Panel A. Earthquakes at time t				
Earthquake dummy t	0.052*	0.065**	0.077***	0.067***
	(0.028)	(0.025)	(0.024)	(0.023)
R-squared	0.410	0.435	0.463	0.295
Panel B. Placebo regressions: Earthquakes at time t+1				
Earthquake dummy t+1	-0.025	-0.025	-0.019	0.009
	(0.018)	(0.019)	(0.018)	(0.025)
R-squared	0.405	0.427	0.451	0.284
Observations	420	420	413	273
Country-by-year FE	Y	Y	Y	Y
District controls	N	Y	Y	Y
Indl controls	N	N	Y	Y
Inc and edu dummies	N	N	N	Y
Countries	40	40	40	32
Regions	288	288	288	212

Notes. OLS estimates. The unit of analysis is a district at time t. The dependent variable is the change in the regional average of answers to the question "How important is God in your life?" (0="not at all important",..., 1="very important"). The earthquake dummy in Panel A is equal to one if one or more earthquakes hit the district in between the interview waves, zero if no earthquake hit. Earthquake in period t+1 in Panel B is a dummy equal to one if one or more earthquakes hit in the period after the interview. District controls are the length of the time period in question and a measure of years since the earthquake. Indl controls indicates male and married dummies, age and age squared, controlled for before aggregation. Inc and edu FE indicates ten income dummies and eight education dummies, controlled for before aggregation. All columns include a constant. standard deviations (in parenthesis) are clustered at the country level. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level, respectively.

Taking the estimate in column (3) of Table 5, Panel A at face value, having been struck by one or more earthquakes increases religiosity by 7.7 percentage points compared to districts that did not experience any earthquakes. This difference corresponds to increasing religiosity from the median district in terms of changes in religiosity to the 80^{th} percentile. In terms of standard deviations, a one standard deviation increase in the probability of being hit by an earthquake increases religiosity by 2.8 percentage points, corresponding to 24% of a standard deviation. Stating the cross-district result in terms of standard deviations, a one standard deviation increase in the long term earthquake risk increases religiosity by 2.4 percentage points, amounting to 7% of a standard deviation.[67] Provided that we can compare the two earthquake probabilities, the fact that the short term effect is larger than the long run effect is consistent with the idea that individuals react to increased stress by increased believing, only to return to a level closer to the long term level when their stress level has decreased. More on the dynamics below.

3.4.5 Robustness

As a placebo check, Panel B of Table 5 replaces the earthquake indicator with the one period lead of the same variable. Reassuringly, districts that experience an earthquake in the future period are not more religious than other districts. This exercise is meant to address the concern that being hit by an earthquake is correlated with some district-level trends that determine the change in religiosity.

Studies have shown that cultural values can be influenced by various events, but that the level tends to revert back towards the long term level after a while (see, e.g., Perrin & Smolek (2009) and Dinesen & Jæger (2013) on the effect of terrorist attacks on trust in government). Consistent with this literature, I find that the impact of earthquakes on religiosity declines over time and vanishes after 5-8 years (Appendix C.3). This finding is hard to explain by selection; if the main results are driven by less traditional people moving out in the face of an earthquake, less traditional individuals should move in again after 5-8 years, only to move out again when the next earthquake hits. Instead this result *can* be explained by religious coping; people use their religion more intensively in the immediate aftermath of an earthquake, which helps them overcome their distress, thus reducing the need for religion after a while. Within the sample, the effect of earthquakes never reaches exactly zero, leaving room for a persistent effect, see Section 4.

The results are robust to using different measures of religiosity. Table A17 reproduces the results in Table 5, using the Strength of Religiosity Scale. Due to the smaller sample size, the significance level falls, but the earthquake dummy remains significant at conventional levels throughout. Table A18 shows that each of the six religiosity measures increase with earthquakes, except "Do you believe in God?", which does not seem to respond to earthquakes. Believing in God was also among the least affected measures in the cross-district analysis and this dimension seems to be a more fundamental part of religiosity, one that is not affected by shocks. Of the remaining measures, church attendance is the least affected.

Using different measures of earthquake instances does not alter the conclusions, either. Omitting district-years with more than one earthquake does not alter the conclusion (Table A19). The actual number of earthquakes does increase religiosity, but Table A19 shows that

[67] The numbers are calculated using the results for the "Importance of God" measure, including the baseline controls corresponding to column (5) of Table 2.

the full effect is driven by the earthquake dummy. That is, it is being hit by one or more earthquakes that matters, not so much the actual number of earthquakes. Note that the districts in this sample experience a maximum of 3 earthquakes, as the districts experiencing more earthquakes fall out of the sample when districts that experienced an earthquake in the year of interview are omitted (as discussed in Section 3.4.2). The results are also robust to using different cutoff levels (Table A13). In particular, earthquakes that hit between 0 and 200 km of the district borders increase religiosity. Including earthquakes that hit further away than 200 km introduces too much noise into the measure and renders the estimate insignificant.

The short term analysis can also shed light on reactions to unpredictability. Religiosity responds more to earthquakes in districts that are rarely hit by earthquakes: Table A21 shows that religiosity increases more in response to an earthquake striking a district located far away from the high risk earthquake zones (from the cross-sectional analysis) or districts that experienced a smaller number of total earthquakes over the period 1973-2014. This again is consistent with testable implication 5 concerning unpredictability.

Earthquakes of magnitudes 6 or above pose a stronger impact on religiosity than smaller earthquakes (Table A20), though the difference is not statistically significant. Earthquakes above magnitude 6 or 6.5 also result in increased believing. Unfortunately, there are too few earthquakes above magnitudes 6.5 to do a proper empirical investigation of these. Furthermore, earthquakes that hit closer to the district borders increase religiosity more (Table A13).

As a last consistency check, Appendix C.8 shows that the impact of earthquakes is not driven by any particular continent.

3.5 Study of persistency

The event study showed that people use their religion more intensively in the immediate aftermath of an earthquake, only to revert back towards their long run level of religiosity after a while. On the other hand, the findings of the cross-sectional analysis were more consistent with the existence of a long-term impact of earthquake risk, even after controlling for actual earthquakes. This section investigates the persistency in more detail by analyzing whether children of immigrants are more religious when their parents came from a country with a higher earthquake risk, compared to children of immigrants from low earthquake risk countries.[68]

To measure religiosity I rely on data from the European Social Survey (ESS), which

[68] The method is called the epidemiological approach and relies on the assumption that cultural values are transferred across generations. See Fernandez (2011) for a handbook chapter on the matter.

includes three questions on religiosity:[69,70] (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").[71] I rescaled the variables to lie between 0 and 1. I restrict the sample to include only persons born in the particular country, but whose mother or father was born in a different country. In cases where the parents migrated from different countries, I choose the mothers' country of origin. In cases where only the father migrated, I choose the fathers' country of origin. This leaves me with 9,412 individuals with parents migrating from 245 different countries. Appendix D shows the case where the focus is on the fathers' country of origin instead. The estimates drop somewhat across all columns, indicating that the impact seems to come mainly from the country of origin of the mother.

I estimate equations of the form:

$$religiosity_{cjat} = \alpha + \beta earthquake_a + \lambda_t + a_c + X'_{cjt}\eta + W'_{at}\delta + V'_{ajt}\eta + \varepsilon_{cjat} \qquad (4)$$

where $religiosity_{cjat}$ is the level of religiosity of a child of immigrants j interviewed at time t living in country c in which he/she was also born, and whose parents migrated from country a. $earthquake_a$ measures the long term earthquake risk in the country of origin, measured by the distance to the nearest earthquake zone 3 or 4 (described in Section 3.3). a_c is a vector of country dummies removing country-wide effects of the child of immigrants' country of residence. X_{cjt} is a vector of immigrant-level controls. W_{at} are socioeconomic and geographic factors in the child of immigrants' country of origin, which might correlate with disaster frequency. V_{ajt} is a vector of socioeconomic characteristics of the immigrant's mother and father.

β measures the impact of earthquake risk in person j's country of origin on person j's current religiosity. The estimate of β now does not include influences from constant factors in the immigrant's current environment, such as, e.g., institutions and culture. Perhaps more importantly, earthquake frequency in the immigrant's country of residence is removed.

The European Social Survey provides three measures of religiosity; people who (1) pray weekly or more often (columns (1)-(3) of Table 7), (2) identify themselves as religious (columns (4)-(6)), and (3) attend religious services regularly (columns (7)-(9)).

Columns (1)-(3) of Table 7 show that the children of immigrants whose parents came from a country located closer to a disaster zone pray more often than children of immigrants

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

[70] Another dataset with information on immigrants' levels of religiosity and country of origin is the General Social Survey (GSS) for the United States. However, the information on the origin of the immigrants is restricted to merely 32 units (comprising 30 countries and two broad regions), compared to 245 in the ESS.

[71] The frequency of attending 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.

whose mothers came from less disaster prone countries. This holds without any controls in column (1) and also when controlling for country-by-year fixed effects (of the immigrants' current country of residence), geographical factors in the parents' country of origin (absolute latitude, continents and distance to the coast), parent characteristics (mother's and father's education), individual-controls (immigrant's age, age squared, sex, income, education) in columns (2) and (3). Likewise, children of immigrants whose mother or father came from a country frequently hit by natural disasters rank themselves as more religious.

The impact of earthquake frequency halves when using instead whether individuals attend religious services as the measure of religiosity. The impact becomes insignificant when all controls are included, confirming the results from Koenig *et al.* (1988) and Miller *et al.* (2014) and the cross-district and event analysis performed here: People do not respond to earthquake risk by going to church, but instead cope with the stress from earthquakes in a more spiritual way by increased beliefs etc.

The results are unchanged when using instead ordered logit estimation.

Table 7. OLS of religiousness on disasters in parents' home country

	(1)	(2)	(3)		(4)	(5)	(6)		(7)	(8)	(9)
Dependent variable:	pray				religious person				service		
Dist(earthquakes), 1000 km	-0.09**	-0.04**	-0.03*		-0.07***	-0.04**	-0.03*		-0.05*	-0.03*	-0.01
	(0.04)	(0.02)	(0.02)		(0.03)	(0.02)	(0.02)		(0.03)	(0.01)	(0.01)
Observations	9,125	9,125	7,741	9,196	9,196	7,796	9,228	9,228	7,825		
R-squared	0.01	0.15	0.20		0.01	0.09	0.13		0.01	0.11	0.13
Org countries	142	142	124		142	142	124		142	142	124
Country and year FE	N	Y	Y		N	Y	Y		N	Y	Y
Geo controls	N	N	Y		N	N	Y		N	N	Y
Parent and indl controls	N	N	Y		N	N	Y		N	N	Y

Notes. OLS estimates. The unit of analysis is a child of immigrants. The dependent variable is answers to the question: "How often do you pray?" (0="Never", ..., 1="Every day") in columns (1)-(3), "How religious are you?" (1="Not at all religious", ..., 1="Very religious") in columns (4)-(6), and "How often do you attend religious services?" (0="Never", ..., 1="Weekly or more often") in columns (7)-(9). Dist(earthquake) measures the distance to the nearest earthquake zone as depicted in Figure 1. "Country and year FE" indicates country - and year fixed effects of the time and place of interview of the children of immigrants. "Geo controls" indicates geographic controls of the country of origin: six continent dummies (Africa, Asia, Australia and Oceania, Europe, North America, and South America), absolute latitude, and distance to coast. "Parent and individual controls" indicates controls for mother's and father's level of education and controls for the child of immigrant's level of education, income, age, age squared, and sex. standard deviations (in parenthesis) are clustered at the level of immigrant's current country and parents' country of origin. Asterisks ***, **, and * indicate significance at the 1, 5, and 10% level, respectively.

The results in Table 7 are consistent with the idea that high earthquake risk leaves a culture of high religiosity which is passed on through generations. Studies have found various psychological benefits of religion, such as increased happiness among religious, various health benefits, and reduced deviant behavior, all traits that parents could want to pass on to their children. Thus, people who have perhaps never themselves experienced an earthquake can still be influenced by the disasters experienced by earlier generations, in terms of increased religiosity. The size of the impact is not significantly different from the effect found in the cross-sectional analysis across the globe; if anything, the effect is larger in the children of immigrants regressions.

4 Conclusion

Some of the least religious districts of the World today are the Berlin district of Germany, the Central Coast of Vietnam, and the Ustecky Kraj district of the Czech Republic with scores on the Strength of Religiosity Scale of 0.14-0.19. At the other end of the spectrum, with a Strength of Religiosity Scale score of nearly one, lies the North-West Frontier in Pakistan, the Borno district in Nigeria, and Jawa Tengah in Indonesia. This paper provides one explanation for some of these global differences in religiosity. Equivalently; since all societies were religious/spiritual if we go far enough back into history (see e.g., Brown (1991) and Murdock (1965)), this research gives one reason why secularization proceeded faster in some societies compared to others.

Individuals that are hit by one or more earthquakes become more religious. After a while, they tend to revert back towards their long-term level of religiosity. This is consistent with the idea that religion can be used to cope with the stress generated by earthquakes, thus lowering the stress-levels and eventually reducing the need for religion. Nevertheless, the small permanent effect seems to accumulate and to be passed on through generations: Children of immigrants whose parents came from high earthquake risk areas are more religious than their counterparts with parents from calmer areas, regardless of the earthquake risk in their current country of residence. The effect can be traced across 900 subnational districts of the World and is not specific to any continent nor to any religious denomination.

The results can be explained within the religious coping framework; when faced with adverse life events, people tend to refer to their religion by praying, rationalizing the event religiously, etc. Consistent with this framework, unpredictable disasters influence religiosity, predictable ones do not; the religiosity of educated, employed, and married individuals responds somewhat less than others, even when controlling for income; intrinsic religiosity is affected more than church going. Most of these results are inconsistent with a story of physical insurance or selection.

This research further provides one explanation of the apparent paradox that religiosity might not decline with increased wealth and knowledge as suggested by the modernization hypothesis. Further, if religiosity 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. Last, this research may help to predict sudden increases in religious fundamentalism.

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Appendix - potentially for online publication

A Matching subnational districts

Steps in matching gridded 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 1981-2009 is variable x048 indicating the subnational district where the interview was conducted. The WVS/EVS "districts" can be both actual districts, but in a few cases also cities. To match the two types of information, I use a shapefile from ESRI with first administrative districts 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 within the district, which is: primary land, large island, medium island, small island, and 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 district is divided into several polygons, I keep only the highest ranked polygon.

3. In many cases, the x048 variable varies across time. For instance, the same country can be divided into 15 districts in one year and only five larger districts in another year. I pick the year(s) where the country is divided into as many districts as possible, but at the same time match the shapefile for first administrative districts as good as possible.

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

5. The districts are illustrated in Figure A1 below. The districts included in the cross-district analysis is the sum of both types of green, while the districts included in the event study are indicated with dark green.

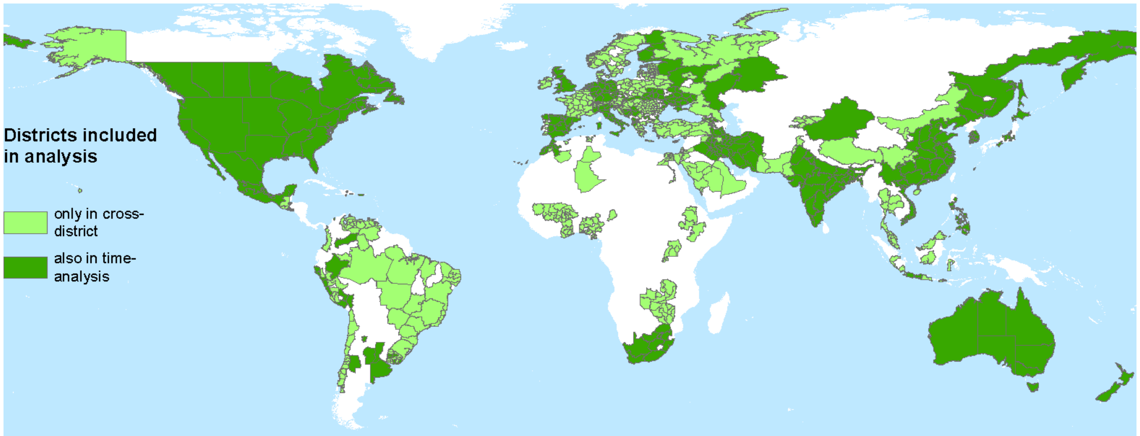


Figure A1. Subnational districts included in the analysis

Notes. Map of subnational districts from the pooled WVS/EVS 1981-2009. Dark green districts are measured more than once in the WVS-EVS, while light green indicates that the district is measured once. Source: Own matching of the variable x48 in the pooled EVS-WVS 1981-2009 dataset to the ESRI shapefile of global first administrative units.

B Additional results for cross-district analysis

Most tables in this appendix replicates column (5) of Table 2 with various robustness checks. For external validity, many tables also include answers to the question "How important is God in your life?" as the dependent variable, as this question has more respondents than the composite Strength of Religiosity measure and since measure is used in the event study. All tables include clustered standard deviations at the subnational district-level.

B.1 Summary statistics

Table A1. Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Strength of Religiosity Scale	106,054	.736	.296	0	1
Dist(earthquakes) 1000 km	211,883	.441	.544	0	3.355
Age	207,293	41.602	16.555	15	108
Male	209,899	.478	.500	0	1
Married dummy	211,193	.575	.494	0	1
Absolute latitude	211,883	34.174	15.064	.119	67.669
Dist(coast) 1000 km	211,883	.239	.257	0	1.990
Area	211,883	130985	298813	.000	2,997,855
Earthquake dummy period t	211,883	.042	.201	0	1
Year	211,883	2002	6.060	1981	2009

B.2 Number individuals in each subnational district

While the main regressions were estimated for districts with more than 10 respondents per year, Table A2 shows the results for the full sample, and the sample excluding districts with less than 10, 50, and 100 respondents respectively. The measure of religiosity in columns (1) through (4) is the Strength of Religiosity Scale, while the measure in columns (5) through (8) is the "Importance of God" measure. The results are not sensitive to the number of respondents.

Table A2. Removing districts with few respondents

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	Strength of Religiosity Scale				Importance of God			
Dist(earthq), 1000km	-0.061***	-0.061***	-0.062***	-0.068***	-0.054***	-0.054***	-0.059***	-0.066***
	(0.016)	(0.016)	(0.017)	(0.021)	(0.014)	(0.014)	(0.016)	(0.020)
Observations	103,362	103,281	98,307	88,081	198,526	198,263	187,178	164,581
R-squared	0.333	0.332	0.331	0.327	0.400	0.400	0.401	0.390
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y
Sample	Full	>10	>50	>100	Full	>10	>50	>100
Districts	600	591	450	315	911	884	646	433
Avg no indls	360.3	360.6	376.9	411.6	333.5	334.0	351.6	389.2

Notes. OLS estimates. The table replicates the result in column (5) of Table 2, varying the limit for the minimum number of respondents in the district and varying the dependent variable. The dependent variable in columns (1)-(4) is Inglehart's Strength of Religiosity Scale [0,1]. The dependent variable in columns (5)-(8) is answers [0,1] to the question "How important is God in your life?". Baseline controls are those included in column (5) of Table 2.

An alternative way to account for the different numbers of respondents across districts is to weight the district observations by the number of respondents in each district. This is done in Table A3 for all the regressions in Table 2. The estimates of the earthquake distance parameters and standard deviations are unaltered.

Table A3. OLS of religiosity on earthquake distance weighted by number respondents

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: Strength of Religiosity Scale [0;1]						
Dist(earthq), 1000km	-0.139***	-0.068***	-0.059***	-0.055***	-0.056***	-0.057***
	(0.036)	(0.017)	(0.016)	(0.016)	(0.016)	(0.013)
Observations	105,947	105,947	105,947	103,283	103,281	66,112
R-squared	0.045	0.273	0.281	0.310	0.310	0.267
Country FE	N	Y	Y	Y	Y	Y
Year FE	N	N	Y	Y	Y	Y
Indl controls	N	N	N	Y	Y	Y
Geo controls	N	N	N	N	Y	Y
Inc and edu FE	N	N	N	N	N	Y

Notes. OLS estimates. The only difference between this table and Table 2 is that the observations are weighted with the number of respondents in each district.

B.3 Different earthquake zones

The main measure of earthquake intensity throughout the paper is the distance to earthquake zones 3 or 4. Table A4 reproduces column (5) of Table 2 using the distance to zones 1-4, 2-4, 3-4, and 4 for the Strength of Religiosity Scale and the "Importance of God" measure. The results do not depend on the choice of zones.

Table A4. Alternative earthquake measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent variable:	Strength of Religiosiity Scale				Importance of God			
Distance to earthq zone 1-4	-0.052*				-0.077***			
	(0.028)				(0.026)			
Distance to earthq zone 2-4		-0.072***				-0.056***		
		(0.028)				(0.020)		
Distance to earthq zone 3-4			-0.061***				-0.054***	
			(0.016)				(0.014)	
Distance to earthq zone 4				-0.021**				-0.015*
				(0.008)				(0.009)
Observations	103,281	103,281	103,281	103,281	198,263	198,263	198,263	198,263
R-squared	0.332	0.332	0.332	0.332	0.400	0.400	0.400	0.400
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y
Districts	591	591	591	591	884	884	884	884
Countries	66	66	66	66	85	85	85	85

Notes. The dependent variable in columns (1)-(4) is Inglehart's Strength of Religiosity Scale [0,1] and the dependent variable in columns (5)-(8) is answers [0,1] to the question "How important is God in your life?". Dist(earthquake) measures the distance in 1000 km to the nearest earthquake-zones 1-4 in columns (1) and (5), distance to zones 2-4 in columns (2) and (6), distance to zones 3-4 in columns (3) and (7), and distance to zone 4 in columns (4) and (8). Baseline controls are those included in column (5) of Table 2.

B.4 Mean earthquake zones

Table A5. OLS of religiosity on average earthquake zones

	(1)	(2)	(3)	(4)
Dependent variable:	Strength of Rel Scale		Importance of God	
Average earthquake zone	0.022	-0.018	0.057***	0.029
	(0.021)	(0.024)	(0.019)	(0.020)
Dist(earthquakes)		-0.067***		-0.045***
		(0.019)		(0.016)
Observations	103,052	103,052	197,910	197,910
R-squared	0.332	0.332	0.400	0.400
Baseline controls	Y	Y	Y	Y
Districts	588	588	881	881
Countries	66	66	85	85

Notes. The dependent variable in columns (1)-(2) is Inglehart's Strength of Religiosity Scale [0,1]. The dependent variable in columns (3)-(4) is answers [0,1] to the question How important is God in your life? Average earthquake zone measures the average earthquake zone within the district calculated across earthquake zones in Figure 1. Dist(earthquake) measures the distance in 1000 km to the nearest high-intensity earthquake-zone (zones 3 or 4). Baseline controls are those included in column (5) of Table 2.

B.5 Actual earthquakes

While the main regressions include controls for whether or not an earthquake hit during the year of interview or the year before, Table A6 shows that the results are unaltered including no controls for actual earthquakes (col 1), only controlling for earthquakes in the year of interview (col 2), in the year of interview and the year before (col 3, equivalent to the main results), in the 2 previous years, and in the 3 previous years. The estimate of the long-term earthquake risk is unchanged. The results are robust to including more lags (results available upon request).

Column (6) shows that the long-term effect declines when an earthquake hit within the last year of the interview. In this latter regression, the sample excludes all districts, where an earthquake hit in the year of interview, since the date of the WVS interview only includes the year of the interview, so I do not know whether the earthquake in this particular year hit before or after the WVS interview (this is equivalent to the method used in the even study). The finding indicates that a short-term effect does exist. The sign and significance of long-term earthquake risk is maintained for the vast majority of the sample. The median district retains the effect of long-term earthquake risk of -0.062 throughout. Furthermore, the mean distance to earthquake zones 3 or 4 for the 21 districts hit by an earthquake within the past year is 0.012. At this level, the composite impact of long-term earthquake risk is -0.048.

Table A6. Accounting for actual earthquakes

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.: Strength of Religiosity Scale [0;1]						
Dist(earthq), 1000km	-0.059***	-0.060***	-0.061***	-0.060***	-0.061***	-0.062***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
Earthquake year t		-0.011	-0.009	-0.009	-0.009	
		(0.010)	(0.011)	(0.011)	(0.011)	
Earthquake year t-1			-0.010	-0.011	-0.010	-0.022*
			(0.008)	(0.008)	(0.009)	(0.012)
Earthquake year t-2				0.004	0.006	
				(0.009)	(0.009)	
Earthquake year t-3					-0.006	
					(0.008)	
Dist(earthq) X earthq t-1						1.142***
						(0.287)
Observations	103,283	103,283	103,281	103,281	103,281	98,640
R-squared	0.332	0.332	0.332	0.332	0.332	0.330
Baseline controls	Y	Y	Y	Y	Y	Y
Sample	Full	Full	Full	Full	Full	Not hit

Notes. OLS estimates. The unit of analysis is individuals surveyed in the pooled WVS / EVS. The dependent variable is Inglehart's Strength of Religiosity Scale [0,1], which is an average (principal components analysis) of answers to six questions on religiosity, depicted in Table 1. Dist(earthquake) measures the distance in 1000 km to the nearest high-intensity earthquake-zone (zones 3 or 4). Baseline controls are those included in column (5) of Table 2. The sample in column (6) includes only districts that were not hit by an earthquake in the same year as the WVS interview.

B.6 Additional controls

Table A7 add controls for trust (col 2, variable a165 from the pooled EVS-WVS), population density (col 3), light density at night per square km (col 4, spatial data available from NASA), arable land shares (col 5, calculated based on irrigated and rainfed agriculture, plate 47 from FAO), average temperatures 1961-1990 (col 6, spatial data from GAEZ), average precipitation and variation therein (cols 7 and 8, spatial data from GAEZ), and a dummy equal to zero if the distance to earthquake zones 3 or 4 is equal to zero (col 9).[72] The motivation for the last control is to make sure that the results are not driven by the difference between zero disaster distance and "the rest". Further, column (10) excludes all districts with earthquake distance zero. Both columns confirm that the main identified effect of earthquake risk is not caused by the difference between zero and non-zero distances. Column (12) includes an interaction term between distance to earthquake zones 3 and 4 and area. The motivation is to account for selection; if migration is a concern, we would expect

[72] In accordance with the work by Ager & Ciccone (2014), I find that increased within-year variation in precipitation increases religiousness.

that people moving away from an earthquake in a small district are more likely to move out of the district compared to people moving out of a large district, provided that they move the same distance. This does not seem to be the case.

Table A7. Additional controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Dependent variable: Strength of Religiosity Scale													
Dist(earthq), 1000km	-0.061***	-0.062***	-0.060***	-0.061***	-0.061***	-0.058***	-0.061***	-0.061***	-0.059***	-0.064***	-0.056***	-0.058***	-0.055***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)	(0.018)	(0.016)	(0.016)
Trust		0.005											0.005
		(0.003)											(0.003)
Popdens 2000			-0.004**										-0.003**
			(0.002)										(0.001)
Lights per km2, 2000				-2.335*	-1.888								-175.143
				(1.338)	(3.634)								(182.840)
Dist(earthq) X Lights per km2					-7.182								126.952
					(53.803)								(200.021)
Arable land (%)						-0.000							-0.000*
						(0.000)							(0.000)
Avg temp 1961-90							0.000						0.001
							(0.001)						(0.001)
Prec 1961-90								0.015					0.000
								(0.010)					(0.016)
Var(prec) 1961-90									0.125***				0.140*
									(0.043)				(0.072)
Disaster>0										0.009			0.011
										(0.010)			(0.010)
Dist(earthq) X Area												-0.025	-0.022
												(0.018)	(0.015)
Observations	103,281	99,656	103,281	103,077	103,077	103,281	103,157	102,395	102,395	103,281	84,419	103,281	98,814
R-squared	0.332	0.332	0.333	0.332	0.332	0.333	0.332	0.333	0.333	0.333	0.335	0.333	0.334
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Sample	full	full	full	full	full	full	full	full	full	full	nonzero	full	full

Notes. OLS estimates. The dependent variable is the Religiosity Scale measure. The unit of analysis is an individual. Baseline controls are those included in column (5) of Table 2. The sample is the fll sample throughout, except in column (11), where the sample excludes districts located within earthquake zone 3 and 4.

B.7 Functional form

Table A8 tests the functional form of the relation between earthquakes and religiosity by restricting the sample in increments of 500 km, taking the logarithm, and including a squared term.

Table A8. Testing the functional form

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Dependent variable: Strength of Religiosity Scale						
Dist(earthq), 1000km	-0.061***	-0.062***	-0.073***	-0.061		-0.064**
	(0.016)	(0.019)	(0.020)	(0.041)		(0.026)
log (1+) Dist(earthq)					-0.089***	
					(0.024)	
Dist(earthq), squared						0.003
						(0.012)
Observations	103,281	100,421	96,418	73,592	103,281	103,281
R-squared	0.332	0.332	0.334	0.314	0.332	0.332
Districts	591	565	503	379	591	591
Countries	66	65	62	52	66	66
Panel B: Dependent variable: Importance of God						
Dist(earthq), 1000km	-0.054***	-0.071***	-0.075***	-0.100***		-0.088***
	(0.014)	(0.018)	(0.020)	(0.036)		(0.023)
log (1+) Dist(earthq)					-0.095***	
					(0.024)	
Dist(earthq), squared						0.020***
						(0.007)
Observations	198,263	186,942	175,652	131,055	198,263	198,263
R-squared	0.400	0.397	0.399	0.396	0.400	0.400
Districts	884	809	723	556	884	884
Countries	85	81	76	65	85	85
Baseline controls	Y	Y	Y	Y	Y	Y
Sample	Full	<1500 km	<1000 km	<500 km	Full	Full

Notes. OLS estimates. The unit of analysis is an individual. The dependent variable in panel A is Inglehart's Strength of Religiosity Scale [0,1]. The dependent variable in panel B is answers [0,1] to the question How important is God in your life? Dist(earthquake) measures the distance in 1000 km to the nearest high-intensity earthquake-zone (zones 3 or 4). Baseline controls are those included in column (5) of Table 2. The sample is restricted to districts located within 1500, 1000, and 500 km of earthquake zones 3 and 4 in columns (2), (3), and (4), respectively.

To further investigate the functional form, Figure A2 depicts binned scatterplots where the distance to earthquake zones 3 and 4 is divided into 50 bins with equally many individuals in each.[73] The religiosity measure is Importance of God in the top panels and the Strength of Religiosity Scale in the bottom panels. The left panels depict the simple correlation without controls, while the right panels include all controls from column (5) of Table 2. The scatters confirm the non-linear relationship: The correlation between earthquake distance and religiosity is higher for lower earthquake distances, and reduces in absolute size as earthquake distance increases. The controls seem to remove this tendency somewhat, making the relation between religiosity and disaster distance more linear.

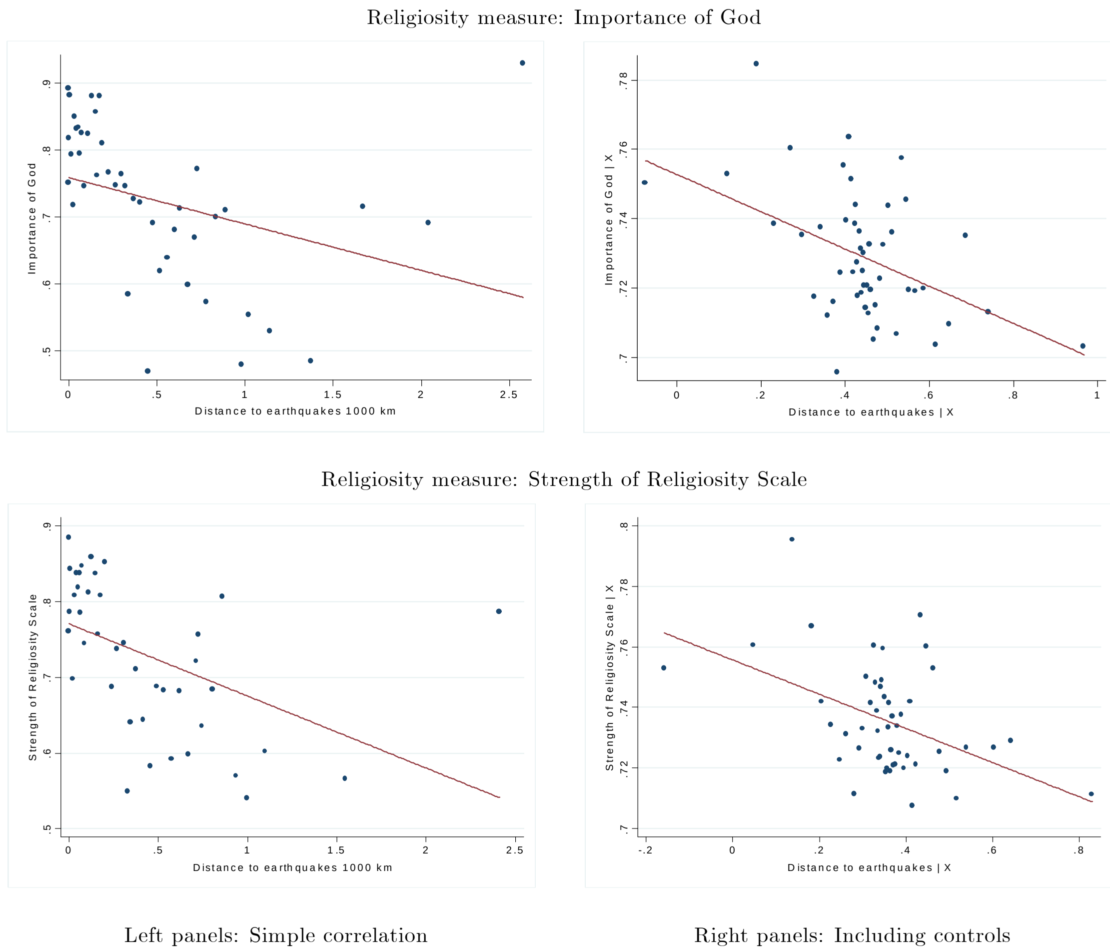
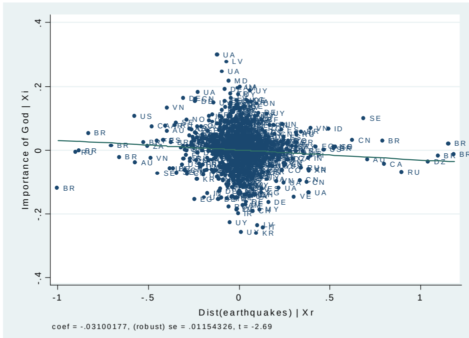


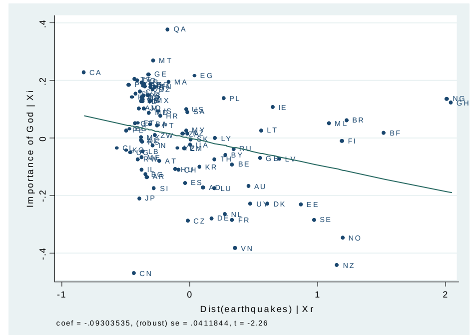
Figure A2. Binned scatter plots of earthquake distance and religiosity

Notes. Binned scatterplots of religiosity and distance to earthquake zones. Earthquake distance is divided into 50 equally sized bins, based on the number of respondents, indicated by one dot. The red line indicates the fitted line of the corresponding OLS regression. The religiosity measure is the Strength of Religiosity Scale. The left panels includes no controls, while the right panels include the baseline controls from column (5) of Table 2.

[73] Bins are created automatically by the binscatter procedure in stata, which means that individuals are divided into 50 equally sized groups. Creating the bins based on groups with the same number of districts in each generates much the same picture.

B.8 Additional AV-plots using importance of God measure





District aggregates Country aggregates

Figure A3. AV-plots of religiosity on earthquake frequency

Notes. AV-plots of OLS estimation, only difference to Figure 3 is that the dependent variable is "Importance of God", which increases the sample to 100 countries in the right plot.

B.9 Alternative measures of religiosity

Table A9 displays the results from estimating equation (1) using each of the six subcomponents of the Strength of Religiosity Scale individually.[74] The baseline controls are included in all columns.[75] The results using the basic Religiosity Scale measure is reproduced in column (1), while columns (2)-(7) show the results for each subcomponent. Higher earthquake risk increases all six measures of religiosity significantly. The average effect on religiosity estimated so far covers large variation across religiosity measures: Earthquakes have the smallest impact on answers to "Do you believe in God?" and church attendance. These estimates are three times smaller than the impact on "Do you believe in an Afterlife".[76]

Table A9. Varying measures of religiosity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable:	rel	impgod	comfort	believe	relpers	afterlife	service
Dist(earthq), 1000km	-0.061***	-0.054***	-0.058***	-0.031*	-0.050***	-0.120***	-0.038**
	(0.016)	(0.014)	(0.020)	(0.018)	(0.019)	(0.026)	(0.016)
Observations	103,281	198,263	126,194	129,909	192,119	120,071	196,859
R-squared	0.332	0.400	0.260	0.223	0.198	0.198	0.270
Baseline controls	Y	Y	Y	Y	Y	Y	Y
Districts	591	884	611	592	880	592	868
Countries	66	85	67	66	84	66	83

[74] A previous version of the paper also performs the analysis for six additional measures with no change to the main conclusions.

[75] Most measures of religiosity are dummy variables, while others are categorical variables. The conclusions are unchanged if instead using probit or ordered probit estimation, respectively.

[76] The difference in estimates is not due to the different samples (results available upon request).

Notes. OLS estimates. The unit of analysis is individuals surveyed in the pooled WVS / EVS. The dependent variable in column (1) is the Strength of Religiosity Scale [0,1] (rel), while the dependent variables in columns (2)-(7) are the subcomponents of this measure (when nothing else is indicated, they are dummy variables with 1="yes", 0="no"): column (2): How important is God in your life? (0="not at all important",..., 1="very important") (impgod), column (3): Do you get comfort and strength from religion? (comfort), column (4): Do you believe in God?, column (5): Are you a religious person? (believe), column (6): Do you believe in life after death? (after), and column (7): How often do you attend religious services? (0="Never, practically never", ..., 1="More than once a week") (service). Dist(earthquake) measures the distance in 1000 km to the nearest high-intensity earthquake-zone (zones 3 or 4). Baseline controls are those included in column (5) of Table 2.

B.10 Global extent of religious coping

The literature investigating the religious coping hypothesis is mainly concentrated around the West. Hence, so far no conclusions can be drawn as to whether Muslims, Buddhists, or Hindus cope in the same way as Christians. In fact, the results so far could potentially be driven by Christians only.

I investigate this by allowing for differential effects of earthquake frequency within the major religions, estimating the following equation:

$$religiosity_{idct} = \alpha + \beta_1 disasters_{dc} + \beta_2 disasters_{dc} \cdot I^g_{idct} + \beta_3 I^g_{idct} + \lambda_t + a_c + X'_{dc}\eta + W'_{idct}\delta + \varepsilon_{idct} \quad (5)$$

where I^g are dummy variables equal to one if individual i belonged to the religious denomination g at time t. g refers to one of the five religions: Christianity (split into Catholicism and Protestantism), Islam, Buddhism, Hinduism and Other religions.[77] $\beta_1 + \beta_2$ is the impact of earthquake frequency for individuals belonging to religion g.[78]

Table A10 shows estimation results for equation 5. Column (1) includes no interaction effects, but simply restricts the sample to the sample where information on individuals' religious denomination is available. The mere restriction of the sample lowers the estimate in absolute value from -0.061 (column 5, Table 2) to -0.045. The reason for the reduction is that we are now comparing people with more similar (higher) levels of religiosity.[79]

[77] The major religions are based on answers to the question "Which religious denomination do you belong to?" (question f025). There are 84 different answers, which I have grouped into the major religions and "Other". The latter cover mainly religious denominations reported as "Other" (54%), Jews (21%), and Ancestral worshipping (13%).

[78] In a previous version of the paper, I include all religious denominations simultaneously in the equation, which I estimate for each of the six religiousness measures that enter the Strength of Religiousity Scale with no change to the main conclusion.

[79] The average level of the Religiosity Scale is 0.74 in the full sample versus 0.81 in the sample, where

Column (2) tests whether Christians react differently to earthquakes than the rest of the World population. On average, Christians do not seem to react differently from the rest, but this covers the fact that Catholics seem to react less than average (column 3), while Protestants react more (column 4).[80] Columns (5), (6), and (8) show that neither Muslims, Hindus nor the Other category react differently than average. Column (7) shows that Buddhists do not seem to react to earthquake frequency in terms of elevated religiosity. This estimate should be taken with caution, though, as Buddhists only amount to 1% of the sample.

Table A10. Across religious denominations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. var.: Strength of Religiosity Scale								
Dist(earthquakes), 1000 km	-0.045***	-0.050***	-0.057***	-0.037**	-0.042***	-0.040***	-0.046***	-0.047***
	(0.014)	(0.017)	(0.014)	(0.015)	(0.014)	(0.012)	(0.014)	(0.014)
Dist(earthquakes) X Christian		0.008						
		(0.011)						
Dist(earthquakes) X Catholic			0.029***					
			(0.010)					
Dist(earthquakes) X Protestant				-0.026**				
				(0.011)				
Dist(earthquakes) X Muslim					-0.010			
					(0.012)			
Dist(earthquakes) X Hindu						-0.032		
						(0.044)		
Dist(earthquakes) X Buddhist							0.104*	
							(0.054)	
Dist(earthquakes) X Other								0.017
								(0.015)
Observations	84,863	84,863	84,863	84,863	84,863	84,863	84,863	84,863
R-squared	0.245	0.246	0.246	0.246	0.248	0.245	0.245	0.245
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y
Districts	580	580	580	580	580	580	580	580
Districts in group		528	505	341	263	60	87	295

Notes. OLS estimates. The unit of analysis is individuals surveyed in the pooled WVS / EVS. The dependent variable is the Strength of Religiosity Scale [0,1]. Dist(earthquake) measures the distance in 1000 km to the nearest high-intensity earthquake-zone (zones 3 or 4) as depicted in Figure 1. Baseline controls are those included in column (5) of Table 2. In addition, all columns include both variables in the interaction term seperately.

In the same vein as with religious denominations, Table A11 allows the impact of distance to earthquakes to vary across continents by including the interaction term $disaster \cdot I_g$, where

respondents have answered which religious group they belong to.

[80] The stronger reaction of Protestants is despite the fact that Protestants live in districts with the lowest earthquake frequency of all adherents (an average distance of 683 km versus 342 km for the average district in the sample of Table 5).

I_g is a dummy variable equal to one if the individual lives on that particular continent. The impact of distance to earthquake zones does not vary across continents.

Table A11. OLS results across continents

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. var.: Strength of Religiosity Scale						
disaster	-0.061***	-0.071***	-0.053***	-0.063***	-0.057***	-0.062***
	(0.016)	(0.021)	(0.014)	(0.019)	(0.020)	(0.018)
Dist(earthquakes) X America		0.048				
		(0.034)				
Dist(earthquakes) X Europe			-0.065			
			(0.078)			
Dist(earthquakes) X Asia				0.007		
				(0.039)		
Dist(earthquakes) X Africa					-0.012	
					(0.033)	
Dist(earthquakes) X Oceania						0.019
						(0.046)
Observations	103,281	103,281	103,281	103,281	103,281	103,281
R-squared	0.332	0.333	0.333	0.332	0.332	0.332
Continent	All	America	Europe	Asia	Africa	Oceania
Country FE	Y	Y	Y	Y	Y	Y
Baseline controls	Y	Y	Y	Y	Y	Y
Inc and edu FE	N	N	N	N	N	N
Districts	591	591	591	591	591	591
Districts within group		97	262	154	69	9

Notes. OLS estimates. The dependent variable is the Strength of Religiosity Scale [0,1]. The unit of analysis is individuals surveyed in the pooled WVS / EVS. Dist(earthquake) measures the distance to the nearest earthquake-zone as depicted in Figure 1. Baseline controls are those included in column (5) of Table 2. In addition, all columns include both variables in the interaction term seperately.

B.11 Data on additional disasters

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.[81] 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 a 10% probability of occurring within the next 10 years. For each district, I calculate the distance to storm intensity zones 2 or above. Storm intensity zones 2 or above are depicted in Figure A4 below as the dark blue areas.

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

[81] Available online at U.S. Geological Survey: http://www.usgs.gov/.

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).[82] The volcanic eruptions were rated using the Volcanic Explosivity Index (VEI), which is a simple 0-to-6 index of increasing explosivity, with each successive integer representing about an order of magnitude increase. For each district, I calculate the distance to volcano risk zones 2 or above. These zones are depicted by the orange areas in Figure A4.

I have not been able to find similar zone data for tsunamis. Instead, the tsunami measure is simply the distance from each district to the nearest tsunami ever recorded. The data on tsunami events is from the Global Historical Tsunami Database from the National Geophysical Data Center (NOAA). The events since 2000 BC were gathered from scientific and scholarly sources, regional and worldwide catalogues, tide gauge reports, individual event reports, and unpublished works. The tsunamis are depicted as the triangles in Figure A4.

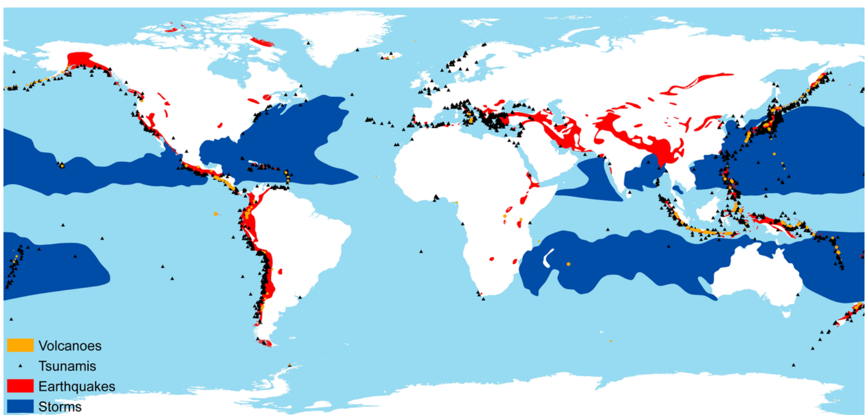
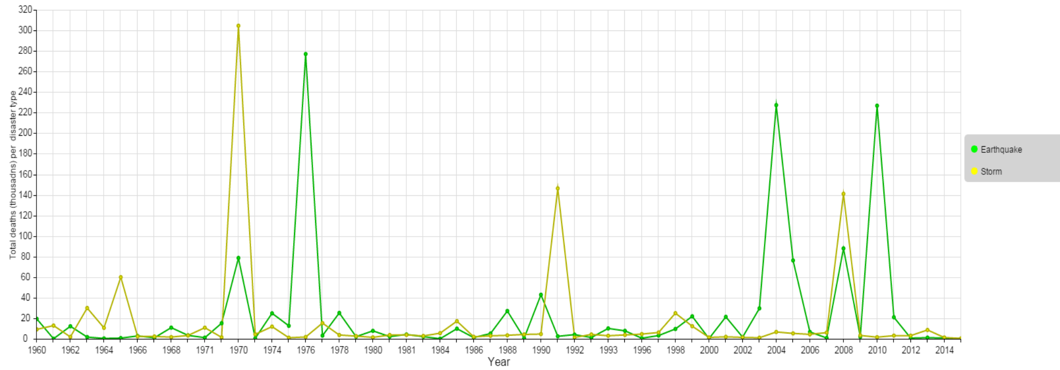


Figure A4. Disaster zones.

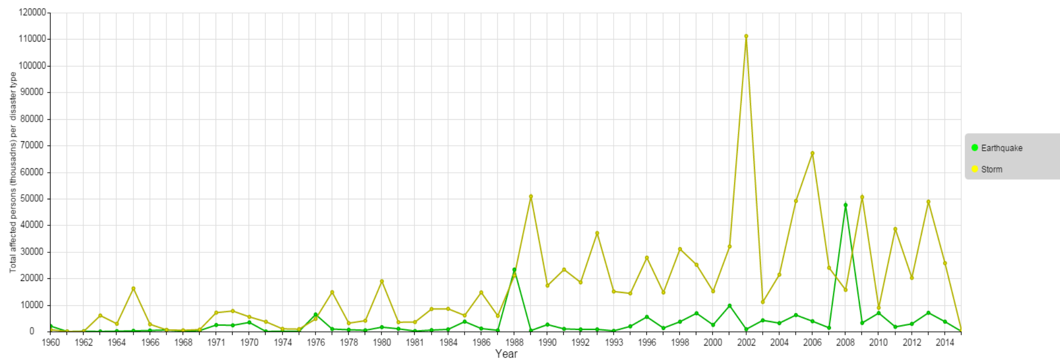
B.12 Severity of earthquakes vs storms

Data from Emdat (int.nat disaster database), 1960-2014.

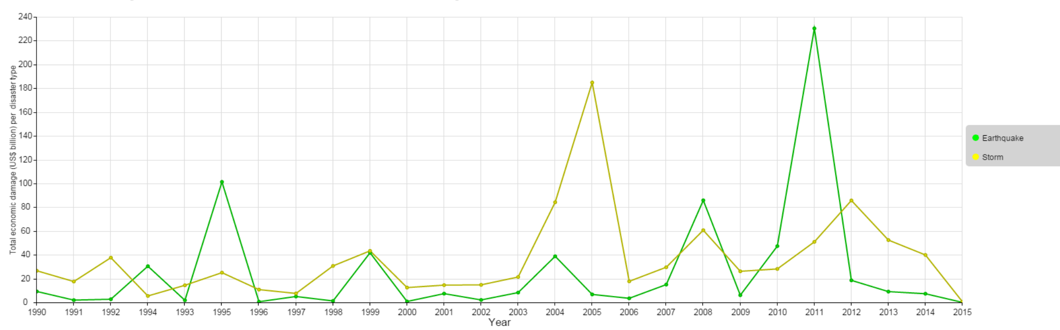
[82] The data was produced digitally by the Smithsonian Institution's Global Volcanism Program, http://www.volcano.si.edu/index.cfm.



Panel A. Deaths from storms and earthquakes



Panel B. People affected by storms and earthquakes



Panel C. Economic damage by storms and earthquakes

Figure A5. Damage by storms and earthquakes

B.13 Differences in religious coping across individuals

Column (1) of Table A12 interacts earthquake distance with the education variable from the pooled WVS-EVS measuring the level of education on a scale from 1 to 8, where 8 is the highest. More educated people do not seem to react differently to natural disasters than the rest in terms of religious coping. However, column (2) shows that earthquakes matter less for the level of religiosity for the top-25% of the education distribution. Column (3) adds income fixed effects with no change to the result. Thus, the lower effect for educated individuals is not due to higher incomes. Two interpretations are that more educated people are more informed in general and hence also about tectonic plates, which reduces the tendency for engaging religious attributions (the part of religious coping interpreting the earthquake as "an act of God"). Second, people with an education may have a larger social network to turn to in times of need.

Columns (4) and (5) show that income does not seem to matter for how much people react to earthquake frequency in terms of religiosity. Columns (6) and (7) show that unemployed people use their religion more in the face of earthquakes, even after controlling for income.[83] One interpretation is that employment brings a social network, which reduces the need for religion in coping.

Last, marriage may also serve as bringing security in a persons life or can be interpreted as an extra coping mechanism; married people don't have to go to God to obtain comfort, which they can obtain from their spouse. Columns (8) and (9) show that married people seem to react less to earthquakes in terms of religious coping, but that the effect is mainly caused by an income effect.

[83] The unemployment dummy is equal to one if the person indicated his/her unemployment status as "Unemployed", zero otherwise. This is variable x028 in the pooled WVS/EVS.

Table A12. Religious coping depending on individual characteristics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dep. var.: Strength of Religiosity Scale [0,1]									
Dist(earthq), 1000km	-0.068***	-0.069***	-0.062***	-0.053***	-0.056***	-0.060***	-0.052***	-0.070***	-0.057***
	(0.017)	(0.016)	(0.015)	(0.016)	(0.015)	(0.016)	(0.014)	(0.017)	(0.014)
Dist(earthq) x Education	0.001								
	(0.001)								
Dist(earthq) x Top 25% education		0.012**	0.011**						
		(0.006)	(0.006)						
Dist(earthq) x Income				-0.000					
				(0.002)					
Dist(earthq) x Top 25% income					-0.001				
					(0.008)				
Dist(earthq) x Unemployed						-0.037***	-0.025***		
						(0.008)	(0.007)		
Dist(earthq) x Married								0.013*	0.003
								(0.008)	(0.005)
Observations	93,655	93,655	63,029	67,273	67,273	95,716	64,529	98,640	67,273
R-squared	0.334	0.333	0.306	0.306	0.305	0.335	0.312	0.330	0.306
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y	Y
Districts	550	550	439	449	449	555	444	560	449
Income FE	N	N	Y	N	N	N	Y	N	Y

Notes. OLS estimates. The unit of analysis is individuals surveyed in the pooled WVS / EVS. The dependent variable is the Strength of Religiosity Scale [0,1]. Dist(earthquake) measures the distance in 1000 km to the nearest high-intensity earthquake-zone (zones 3 or 4) as depicted in Figure 1. Baseline controls are those included in column (5) of Table 2. In addition, all interaction models include both the interaction term and the particular variable individually.

C Additional results for within districts analysis

All standard deviations are calculated as in Table 5.

C.1 Varying cutoff levels

The main earthquake measure for the within-district analysis defines a district as being hit by an earthquake if the closest earthquake hit within 100 km of the district borders. Table A13 varies the cutoff level from 0 to 300 km in increments of 25 km. The reason for the varying number of observations is that district-years are thrown out if an earthquake hit in the year of the interview, discussed in the main text.

Table A13. Varying cutoff-levels

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Dependent variable: D. Importance of God													
Earthquake dummy	0.065***	0.061***	0.074***	0.076***	0.077***	0.060***	0.063***	0.049***	0.058***	0.042**	0.018	-0.015	0.030*
	(0.020)	(0.017)	(0.024)	(0.025)	(0.024)	(0.011)	(0.021)	(0.018)	(0.021)	(0.020)	(0.036)	(0.031)	(0.017)
Observations	434	425	418	417	413	404	395	386	385	378	375	370	366
R-squared	0.454	0.455	0.459	0.460	0.463	0.454	0.453	0.446	0.448	0.447	0.444	0.435	0.439
Cutoff	0	25	50	75	100	125	150	175	200	225	250	275	300
Baseline controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
District-years with earthquake	14	21	29	35	40	43	46	51	53	51	52	54	61
Total earthquakes	20	28	42	58	68	74	78	86	90	85	99	92	111

Notes. OLS estimates. The dependent variable is the change in the district average of answers to the question "How important is God in your life?" (0="not at all important",..., 1="very important"). The unit of analysis is regions at different points in time. Baseline controls include all controls from column (3), Table 5.

C.2 Varying model specifications

Alternative models are depicted in Table A14. Column (1) reproduces the main result from column (3), Table 5. Column (2) adds the initial level of religiosity, reducing the impact of earthquakes somewhat, but not significantly. On average, districts with higher initial religiosity see a smaller change in religiosity. Column (3) allows the impact of earthquakes to vary for different levels of initial religiosity. In keeping with the religious coping hypothesis, we expect that religiosity increases more in response to earthquakes in districts where religiosity is higher. On the other hand, religiosity cannot increase as much in high-religiosity districts as in low-religiosity districts. Thus, finding an insignificant interaction term is not very informative.

So far, district fixed effects were removed by regressing on changes in religiosity. Instead, column (4) regresses on the level of religiosity, including district fixed effects. The result is unaltered; higher earthquake risk increases religiosity.

Table A14. Alternative models

	(1)	(2)	(3)	(4)
Dependent variable: D. Importance of God				Level of impgod
Earthquake dummy	0.077***	0.059***	0.062**	0.038**
	(0.024)	(0.015)	(0.029)	(0.019)
Earthquake dummy X initial rel			-0.029	
			(0.138)	
Importance of God t-1		-0.592***	-0.591***	
		(0.119)	(0.118)	
Observations	413	413	413	695
R-squared	0.463	0.628	0.629	0.953
Baseline controls	Y	Y	Y	Y
District fixed effects	N	N	N	Y

Notes. OLS estimates. The dependent variable is the change in the district average of answers to the question "How important is God in your life?" in columns (1)-(3) and the level of the same variable in column (4). The unit of analysis is districts at different points in time. Baseline controls include all controls from column (3), Table 5.

C.3 Dynamics

The main results are based on a very unbalanced panel, where the window of observation varies from 2 to 17 years. This matters for the results, as the impact of earthquakes seems to dwindle after a while. Table A15 estimates the effects of earthquakes for different period lengths. In line with the idea that religiosity increases in the immediate aftermath of the earthquake, only to fall back towards the long term level when stress relief has stepped in, the impact of earthquakes is smaller when religiosity is measured more than 5 years apart, but only significantly so by 7 years and up. In fact, when religiosity is measured more than 7 years apart, the impact of earthquakes is indistinguishable from zero. Note, however, that the estimate on earthquakes never exactly reaches zero.

Table A15. Religious coping dynamics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dep. var.: D.Importance of God							
Earthquake dummy	0.077***	0.044***	0.137*	0.113**	0.080***	0.080***	0.080***
	(0.024)	(0.011)	(0.078)	(0.049)	(0.026)	(0.026)	(0.026)
Earthquake X period length > $cutoff$		0.036	-0.079	-0.062	-0.060*	-0.060*	-0.060*
		(0.031)	(0.081)	(0.051)	(0.033)	(0.033)	(0.033)
Observations	413	413	413	413	413	413	413
R-squared	0.463	0.463	0.465	0.465	0.463	0.463	0.463
Cutoff		4	5	6	7	8	9
Baseline controls	Y	Y	Y	Y	Y	Y	Y

Notes. OLS estimates. The unit of analysis is the subnational district-year from the pooled WVS / EVS. The dependent variable is the change in "Importance of God" from period t-1 to period t. Baseline controls include all controls from column (3), Table 5. Columns (2) - (7) include an interaction between the earthquake dummy and a dummy for whether the period length is larger than the consecutively increasing cutoff.

The results in Table A15 could be driven by the idea that district characteristics differ across districts that are interviewed more or less often. An alternative check of the dynamics is to interact the earthquake dummy with years since the earthquake hit, which is done in Table A16. The effect of earthquakes starts to decline after 2 years, but only significantly so after 5 years. In fact, when the earthquake hit more than five years ago, the effect on religiosity has almost vanished.

Table A16. Religious coping dynamics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable: D.Importance of God							
Earthquake dummy	0.055	0.078	0.085*	0.081*	0.065*	0.076**	0.071**
	(0.046)	(0.049)	(0.046)	(0.045)	(0.034)	(0.036)	(0.029)
Earthquake dummy X years since earthquake > cutoff	0.011	-0.033	-0.045	-0.034	-0.061*	-0.072*	-0.067**
	(0.053)	(0.051)	(0.048)	(0.049)	(0.034)	(0.036)	(0.029)
Observations	413	413	413	413	413	413	413
R-squared	0.461	0.463	0.462	0.461	0.461	0.461	0.461
Cutoff	1	2	3	4	5	6	7
Baseline controls	Y	Y	Y	Y	Y	Y	Y

Notes. OLS estimates. The unit of analysis is the subnational district-year from the pooled WVS / EVS. The dependent variable is the change in "Importance of God" from period t-1 to period t. All controls from column (3), Table 5 included in all columns. Variables described in the main text. All columns include an interaction between the earthquake dummy and a dummy for whether the years since the earthquake is larger than the consecutively increasing cutoff.

C.4 Alternative religiosity measures

Table A17 reproduces Table 5 using instead the Strength of Religiosity Scale as measure of religiosity.

Table A17. First-difference estimation with different religiosity measure

	(1)	(2)	(3)	(4)
Dependent variable: D. Strength of Religiosity Scale				
Panel A. Earthquakes at time t				
Earthquake dummy t	0.030**	0.032*	0.037*	0.032*
	(0.014)	(0.017)	(0.018)	(0.017)
R-squared	0.388	0.390	0.411	0.413
Panel B. Placebo regressions: Earthquakes at time t+1				
Earthquake dummy t+1	0.011	0.009	0.014	0.006
	(0.017)	(0.021)	(0.019)	(0.023)
R-squared	0.384	0.385	0.404	0.404
Observations	234	234	227	125
Country-by-year FE	Y	Y	Y	Y
District controls	N	Y	Y	Y
Indl controls	N	N	Y	Y
Inc and edu dummies	N	N	N	Y
Countries	23	23	23	14
Regions	175	175	175	115

Notes. The only difference to Table 5 is that the dependent variable is the change in the district average of the Strength of Religiosity Scale.

Table A18 shows the main regressions for the individual measures of religiosity. Panel A shows the results corresponding to the specification in column (3) of panel A of Table 5. Most religiosity measures are higher in districts hit by an earthquake compared to those not hit, although the only measure influenced significantly is answers to the question "How important is God in your life?" As the panel data is highly unbalanced with different districts measured in different intervals, panel B adds the interaction between the earthquake dummy and the length of the observation window. In line with the results in Tables A15 and A16, the interaction term is either insignificant or significantly negative. When accounting for the different period lengths, more religiosity measures become significantly affected by earthquakes. The only measure which is never affected is answers to the question "Do you believe in God?". The interpretation could be that this question is a more fundamental part of religiosity; whether you believe or not cannot be affected by schocks, but to which degree you believe and how much comfort you feel you gain from believing is influenced. The rest of the measures are significantly affected in at least one of the specifications. Disregarding beliefs in God, the least affected dimension is church attendance with the highest significant estimate across all rows being 0.039, nearly four times smaller than the second-smallest estimate, which is answers to "Do you find comfort in God" with the highest estimate of 0.129.

Table A18. Alternative religiosity measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable	drel	dimpgod	dcomfort	dbelieve	drel_pers	dafter	dservice
Panel A. Baseline regressions							
Earthquake dummy	0.037*	0.077***	0.000	-0.001	0.037	0.052	0.029
	(0.018)	(0.024)	(0.021)	(0.012)	(0.025)	(0.059)	(0.032)
Panel B. Allowing for differential effects across different observation windows							
Earthquake dummy	0.058***	0.044***	0.129*	0.025	0.147***	-0.042	0.039*
	(0.013)	(0.011)	(0.063)	(0.028)	(0.052)	(0.037)	(0.020)
Earthquake X period length > 4 years	-0.023	0.036	-0.144**	-0.029	-0.120*	0.105	-0.011
	(0.020)	(0.031)	(0.062)	(0.030)	(0.060)	(0.081)	(0.037)
Earthquake dummy	0.035	0.137*	0.023	-0.013	0.131**	0.040	-0.036
	(0.035)	(0.078)	(0.059)	(0.036)	(0.049)	(0.069)	(0.043)
Earthquake X period length > 5 years	0.003	-0.079	-0.031	0.017	-0.120**	0.017	0.084
	(0.039)	(0.081)	(0.057)	(0.035)	(0.056)	(0.110)	(0.052)
Earthquake dummy	0.059*	0.113**	0.021	-0.000	0.058	0.141*	0.050
	(0.029)	(0.049)	(0.042)	(0.026)	(0.051)	(0.069)	(0.071)
Earthquake X period length > 6 years	-0.039	-0.062	-0.036	-0.001	-0.034	-0.156**	-0.035
	(0.026)	(0.051)	(0.039)	(0.024)	(0.056)	(0.071)	(0.068)
Earthquake dummy	0.037*	0.080***	0.000	-0.001	0.048**	0.052	0.035
	(0.018)	(0.026)	(0.021)	(0.012)	(0.023)	(0.059)	(0.034)
Earthquake X period length > 7 years		-0.060*			-0.099		-0.060
		(0.033)			(0.105)		(0.039)
Observations	227	413	229	230	434	230	447
R-squared	0.411	0.463	0.246	0.387	0.471	0.382	0.521
Baseline controls	Y	Y	Y	Y	Y	Y	Y
Countries	23	40	24	24	39	24	39
Districts	175	288	176	176	296	176	309

Notes. OLS estimates. The dependent variable is the district aggregate of the change in the Strength of Religiosity Scale (drel) in column (1) and each of the six components separately in columns (2)-(7): The change in answers to "How important is God in your life?" (dimpgod) in column (2), "Do you find comfort in God?" (dimpgod) in column (3), "Do you believe in God?" (dbelieve) in column (4), "Are you a religious person?" (drel_pers) in column (5), "Do you believe in Afterlife?" (dafter) in column (6), and "How often do you attend religious services?" (dservice) in column (7). The earthquake dummy is equal to one if one earthquake hit the district in between the interview waves, zero if no earthquake hit, and missing if more than one earthquake hit. The unit of analysis is subnational district-years. All regressions include the list of standard controls from column (3) of Table 5. Panel B shows 4 sets of regressions for each religiosity measure, adding the interaction term between the earthquake dummy and an indicator variable equal to one if there were more than 4, 5, 6, and 7 years in between interview waves, respectively.

C.5 Different measures of earthquake instances

Table A19 investigates whether the number of earthquakes matter. Column (1) reproduces the main result from column (3) of Table 5, panel A, where the earthquake measure is a dummy equal to one if the district was hit by one or more earthquake in between interview waves. Column (2) includes instead the actual number of earthquakes. The parameter estimate is significant, but becomes insignificant when including the earthquake dummy in column (3), indicating that the actual number of earthquakes does not matter much, but rather whether or not the district was hit. This result should be taken with caution, as only 14 districts in the sample are hit by more than one earthquake. Note again that this small number is due to the fact that the districts hit by an earthquake in the year of interview are excluded from the analysis, since it is not possible to determine whether these earthquakes hit before or after the interview. This excludes districts that are hit often. Column (4) shows that the results are not driven by the districts that are hit by more than one earthquake.

Table A19. Religious coping dependent on earthquake characteristics

	(1)	(2)	(3)	(4)
Dependent variable: D.Importance of God				
Earthquake dummy	0.077***		0.071**	0.080***
	(0.024)		(0.031)	(0.028)
Number earthquakes		0.029***	0.004	
		(0.010)	(0.010)	
Observations	413	413	413	399
R-squared	0.463	0.457	0.463	0.462
Baseline controls	Y	Y	Y	Y
Sample	full	full	full	<=1 eq

Notes. OLS estimates. The dependent variable is the change in the district aggregate of answers to the question "How important is God in your life?" (0="not at all important",..., 1="very important"). The unit of analysis is subnational districts. All regressions include both interaction terms in addition to the list of baseline controls from column (3) of Table 5.

C.6 Different magnitudes

The main results are based on earthquakes of magnitude 6 or above. Table A20 uses different magnitude cutoffs, ranging from 5 or above in column (1) to 6.5 or above in column (6). Note that the magnitude scale is logarithmic, so that the shaking felt at magnitude 6 is ten times larger than the magnitude felt at magnitude 5.

One caveat of the table is that the sample throughout all columns excludes the districts that were hit in the year of interview (see the main text for the argument). For a proper comparison, though, the sample should exclude districts that were hit by an earthquake of 5 or above in the year of interview. Since there are many earthquakes of magnitude 5 or above, the sample size drops tremendously and also excludes most districts that were hit by one or more earthquakes, including all districts with earthquakes of magnitude 7 or above. This setup biases the results towards earthquakes of magnitudes 6 or above being most significant.

The table shows that the estimate on earthquakes increases monotonically throughout columns (1)-(4), when restricting the earthquakes to those of magnitudes 5 or above to 6 or above.[84] Restricting the magnitude cutoff to earthquakes above magnitude 6, reduces the number of earthquakes to 54 and also increases the standard deviations somewhat, leaving the parameter estimate unchanged. Restricting to earthquakes of magnitude 6.5 or above reduces the number of earthquakes to 20. Nevertheless, these larger earthquakes still result in elevated religiosity.

Table A20. Accounting for different magnitudes

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: D.Importance of God						
Dummy=1 if earthquake of magnitude 5 or above	0.027					
	(0.019)					
Dummy=1 if earthquake of magnitude above 5		0.040				
		(0.025)				
Dummy=1 if earthquake of magnitude 5.5 or above			0.040***			
			(0.012)			
Dummy=1 if earthquake of magnitude 6 or above				0.077***		
				(0.024)		
Dummy=1 if earthquake of magnitude above 6					0.077**	
					(0.029)	
Dummy=1 if earthquake of magnitude 6.5 or above						0.048**
						(0.019)
Observations	413	413	413	413	413	413
R-squared	0.455	0.459	0.456	0.463	0.463	0.454
Baseline controls	Y	Y	Y	Y	Y	Y
Number earthquakes	880	661	239	68	54	20

Notes. OLS estimates. The dependent variable is the change in the district aggregate of answers to the question "How important is God in your life?" (0="not at all important",..., 1="very important"). The unit of analysis is subnational districts. The earthquake measure is equal to one if an earthquake of magnitude X or above hit in between interview waves. The cutoff for the magnitudes varies across columns from magnitude 5 or above in column (1) to 6.5 or above in column (6). Baseline controls include all controls from column (3) of Table 5.

C.7 Surprise earthquakes

Table A21 investigates the surprise element of the effect, i.e., whether the impact of earthquakes is higher for earthquakes that strikes districts that are less often hit in general. The

[84] Note that the number of earthquakes drop sharply when moving from magnitudes 5 or above to magnitudes above 5. Indeed, there are disproportionately many earthquakes of magnitude 5, probably because of rounding of the reported magnitudes.

main result from column (3) of Table 5 is reproduced in column (1). Column (2) interacts with the earthquake measure used in the cross-sectional study: distance to the nearest earthquake zone 3 or 4 (the highest intensity zones). When restricting to the sample of districts measured less than 7 years apart, the interaction term is positive, confirming the surprise element. Columns (4) and (5) interacts instead with a dummy measuring whether an earthquake hit during the previous period. The interaction is not statistically different from zero at conventional levels, but when restricting to districts measured less than 7 years apart, the p-value of the interaction equals 0.132. Columns (6) and (7) interacts instead with the number of earthquakes striking the district over the period for which data is available; 1973-2014. All results are consistent with the surprise element; religion increases more in the aftermath of an earthquake in districts that are less frequently hit by earthquakes.

Table A21. Surprise earthquakes

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable: D.Importance of God							
Earthquake dummy	0.077***	0.076***	0.050*	0.084**	0.133**	0.095***	0.145**
	(0.024)	(0.022)	(0.028)	(0.035)	(0.057)	(0.035)	(0.061)
Earthquake X Dist(earthq zones)		0.001	0.621***				
		(0.046)	(0.189)				
Earthquake dummy t X earthquake dummy t-1				-0.038	-0.069		
				(0.045)	(0.044)		
Earthquake dummy X no. earthquakes 1973-2014						-0.003	-0.005*
						(0.002)	(0.003)
Observations	413	413	252	413	252	413	252
R-squared	0.463	0.463	0.343	0.464	0.332	0.464	0.332
Baseline controls	Y	Y	Y	Y	Y	Y	Y
Sample	full	full	<7 years	full	<7 years	full	<7 years

Notes. OLS estimates. The dependent variable is the change in the district aggregate of answers to the question "How important is God in your life?" (0="not at all important",..., 1="very important") (dimpgod) in columns (1)-(3) and the change in the Strength of Religiosity Scale (drel) in columns (4)-(6). The unit of analysis is subnational districts. Baseline controls include all controls from column (3) of Table 5.

C.8 Across continents

Table A22 shows that earthquakes result in increased religiosity within all continents. The population of Oceania seem to react a bit more to earthquakes, while Europeans react more than average. Panel B shows that this is mainly driven by the fact that the timespans between the waves are shorter in Europe and longer in Oceania, which falls out in the restricted sample. Only 7 districts from Oceania are included in the sample.

Table A22. Allowing for differential effects across continents

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: D.Importance of God						
Panel A: Full sample						
Earthquake dummy	0.077***	0.078***	0.084***	0.050**	0.080***	0.073***
	(0.024)	(0.026)	(0.030)	(0.025)	(0.026)	(0.024)
Earthquake X Africa		-0.018				
		(0.036)				
Earthquake X America			-0.053			
			(0.037)			
Earthquake X Asia				0.037		
				(0.048)		
Earthquake X Oceania					-0.060*	
					(0.033)	
Earthquake X Europe						0.101***
						(0.026)
Observations	413	413	413	413	413	413
R-squared	0.463	0.463	0.463	0.463	0.463	0.463
Panel A: Sample restricted to periods of less than seven years						
Earthquake dummy	0.113**	0.120**	0.131**	0.074**	0.113**	0.107*
	(0.050)	(0.057)	(0.060)	(0.029)	(0.050)	(0.055)
Earthquake X Africa		-0.060				
		(0.062)				
Earthquake X America			-0.086			
			(0.061)			
Earthquake X Asia				0.067		
				(0.084)		
Earthquake X Oceania						
Earthquake X Europe						0.068
						(0.056)
Observations	252	252	252	252	252	252
R-squared	0.328	0.329	0.330	0.330	0.328	0.329
Baseline controls	Y	Y	Y	Y	Y	Y

Notes. OLS estimates. The dependent variable is the change in the district aggregate of answers to the question "How important is God in your life?" (0="not at all important",..., 1="very important"). The unit of analysis is subnational districts. Baseline controls include all controls from column (3) of Table 5.

D Additional results for cross-immigrants regressions

While Table 7 treated the mothers' country of origin as the main country of origin, Table A23 does the opposite. Table A23 reproduces Table 7 where the country of origin is the father's country of origin when the parents' country of origin differ. In cases where the father was not an immigrant, the mothers' country of origin is chosen.

Table A23. OLS of religiousness on disasters in parents' home country, focus on father

	(1)	(2)	(3)		(4)	(5)	(6)		(7)	(8)	(9)
Dependent variable:	pray				religious person				service		
Dist(earthquakes), 1000 km	-0.09**	-0.04**	-0.03	-0.07***	-0.04**	-0.03	-0.05*	-0.02*	-0.01		
	(0.04)	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.01)	(0.02)		
Observations	9,078	9,078	7,726	9,145	9,145	7,780	9,177	9,177	7,809		
R-squared	0.01	0.15	0.20	0.01	0.08	0.13	0.00	0.11	0.14		
Org countries	142	142	124		142	142	124		142	142	124
Country and year FE	N	Y	Y		N	Y	Y		N	Y	Y
Geo controls	N	N	Y		N	N	Y		N	N	Y
Parent and indl controls	N	N	Y		N	N	Y		N	N	Y

Notes. The Table reproduces Table 7, but where the country of origin of the father is first chosen and then replaced by the mother's when the father is not an immigrant.