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Abstract

Broadly speaking, this dissertation project seeks to address the following question: how do religious people think about the cultural authority of science, and to what extent does this vary across different contexts? Despite the predictions of classical modernization theorists, religious institutions continue to significantly shape public discourse—and rule-making—in the vast majority of societies. The few exceptions to this are well-known, such as the increasingly secular countries of Western Europe. There is a growing sociological (and interdisciplinary) literature at the nexus of science and religion; and this dissertation attempts to contribute to ongoing areas of research by addressing existing limitations and debates using new analytical approaches.

In Empirical Paper 1 (Chapter 2), I develop and test a new religio-political framework for studying the cultural authority of science in the U.S. context. Existing designs have tended to primarily consider the predictive effects of religious identity or political ideology/party identification. However, I argue that there are good reasons to expect differences among partisan subsets of major religious groups: Protestant literalists, Protestant non-literalists, and Catholics. The results show that there is significant evidence of within-group heterogeneity. Contrary to popular narratives, generalized trust in science has not declined broadly among Protestant fundamentalists (biblical literalists) since the 1980s—but rather, only among Republican literalists. The results also show that there are significant differences between Democratic and Republican literalists when it comes to specific contested scientific issues. For example, while both Democratic and Republican literalists are less likely to accept human evolution and the Big Bang, the impact of literalism is substantially greater among Republicans.

The next two papers use data from the World Values Survey (WVS) to study the link between religious identity and the cultural authority of science in cross-national contexts. In Paper 2 (Chapter 3), I use an approach that combines resampling methods and unsupervised machine learning to measure cross-national variation in religiosity and science attitudes. There are a few papers that have used similar methods (i.e., latent class analysis) in the U.S. context, finding that a significant proportion of U.S. adults have favorable attitudes toward both religion and science (DiMaggio et al. 2018; O'Brien and Noy 2015). However, this paper extends the existing literature by demonstrating that there are significant numbers of post-secularists (pro-religion and pro-science) in most societies; and, by explicitly quantifying how key religio-scientific classes (traditionalists, modernists, post-secularists, postmodernists) are distributed across regions, countries/territories, and religious groups.

Whereas Paper 2 is concerned with measuring latent religio-scientific classes, Paper 3 (Chapter 4) examines what happens when religion and science explicitly conflict in the public sphere. In particular, who chooses to support religion given a conflict—and to what extent is this predicted by science optimism, moral concerns about science, religiosity, and religious exclusivism? Overall, the results showed that despite the arguments of the cultural ascendancy and alienation theses, general science attitudes have a relatively weak predictive effect on the outcome. Instead, it is religiosity and (especially) religious exclusivism that have significantly stronger predictive effects. These differences are also largely consistent in models that assessed relationships within countries/territories and by major religious groups. I conclude Paper 3 with a discussion of why these results have implications for key social scientific theories and perspectives (e.g., modernization).

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Chapter 1: Introduction

What is Science?

My dissertation project is broadly about the link between religious identity and the cultural authority of science. But first, it is necessary to define what "science" entails in the context of this project. By "science," I am referring to the established body of scientific knowledge, the scientists conducting the research, and the mainstream scientific institutions supporting this work (e.g., see Gauchat 2012, 2015; Gieryn 1999; Oreskes 2019). Science is broadly defined to include the "who" (scientists, scientific institutions) and "what" (scientific research, evidence, theories) associated with the natural, physical, and social/behavioral sciences. Following other sociologists of science, I also conceptualize science as a social institution, in that it has its own set of norms (e.g., training, methods, ethics), seeks to expand its resources/influence, and protects the boundaries of the profession (Gieryn 1999; Merton 1973; Shapin 1995).

The Cultural Authority of Science (CAS)

When science enjoys a great deal of cultural authority in a society, people are more likely to believe that science is worthy of public funding and that scientific research should influence how society is run (Gauchat 2015). For example, in such societies, social scientific evidence would guide the development of policies in areas such as crime, public education, and immigration; (2) medical experts would guide the design of public health guidelines, such as during the ongoing

Covid-19 pandemic (Plohl and Musil 2020). Moreover, this general conception of cultural authority applies to other institutions as well. In countries around the world, religious values are frequently invoked to justify the support for or opposition to a large number of public policies and programs (e.g., abortion, gender relations). In the U.S., religious groups are even (indirectly) subsidized by the state in that members of religious organizations can make donations (or "offerings") that are tax-deductible.

A Key Prerequisite of Cultural Authority: Public Trust

The primary prerequisite or antecedent of cultural authority is a high degree of public trust in the institution. The social world is incredibly complex, especially in modern societies. Due to information asymmetries and other sources of uncertainty and risk, all types of social relationships require at least some measure of trust (Coleman 1990; Lewis and Weigert 1985; Robbins 2016). In an important way, trust is the sociological answer to the problems of complexity and risk. Given the centrality of trust in human societies, social scientists have devoted much attention to the subject (Lewis and Weigert 1985; Nannestad 2008; Robbins 2016; Uslaner 2003). Although there are numerous conceptions of trust, in the context of this paper (i.e., given the focus of trust in institutions), there are two key components: perceived *competence* and *goodwill* regarding the matter at hand.

In societies with higher levels of public trust in science, both members of the general population as well as elites (e.g., policymakers) are more likely to value and seek out the advice of scientists. This is because there are gains in both efficiency and strategy. At the individual-level, people who trust science can "outsource" decisions to save time, money, and effort (Lewis and Weigert 1985). Lawmakers use a similar logic: i.e., they often use existing research instead of conducting their own. In addition, there are also strategic payoffs: e.g., policymakers can seem less biased by implementing evidence-based programs; moreover, when things go badly, they are less culpable. After all, they can argue that policy X was implemented because that is what the evidence supported; thus, if the policy fails, it is supposedly the fault of the research, and not the policymakers who merely followed the evidence.

Why Trust Science?

Why should people trust in science at all? The dominant view, the "cultural ascendancy" thesis, has its intellectual roots in social psychology, functionalism, and the rise of modernity (Gauchat 2012). According to the cultural ascendancy thesis, scientists have generally proven that they are both competent and good willed. In modern societies, the division of labor tends to be more complex and differentiated. As such, many jobs require specialized training and expertise (Gieryn 1983; Oreskes 2019). Scientists spend years undergoing extensive training and finishing formal education in order to acquire specialized knowledge in their respective domains; their expertise is usually signaled by a relevant formal credential such as a PhD or MD (Collins and Evans 2002). Their innovations and other widely publicized accomplishments have enhanced the cultural authority and prestige of the profession. Biologists, chemists, doctors, and engineers have invented a countless number of products that have greatly improved the productivity, output, and overall quality of human life: e.g., more efficient machines, crops with bigger yields, living-saving medical treatments (Barber 1990; Bennett 2019; Sachdev 2014). Social scientific research has been used to advance our understanding of the causes and consequences of crime, discrimination, intergroup conflicts, polarization, homelessness, social inequality, and a host of other pressing social and behavioral issues (e.g., Quillian et al. 2020a, 2020b).

Many scientists have also sought to cultivate public trust in their integrity and goodwill by promoting transparency in research practices and inviting attempts to replicate findings (Latour and Woolgar 1979). More recently, experimental work in the social sciences has been undergoing a "preregistration revolution," which seeks to reduce researcher biases and improve public trust in research findings (Nosek et al. 2018). In addition, scientists regularly tout their objectivity and argue that their research agendas and findings are free of biases—whether from corporate interests, political preferences, and so on (Jasanoff 2004; Gieryn 1999). In sum, the modernist argument is that as societies become increasingly complex, public confidence in science will continue to grow as long as scientists are able to prove their competence and objectivity. In this view, to trust scientists is to trust that they have both the technical capacity and moral inclination to make accurate truth claims about the operation of natural, physical, and social phenomena in the world.

While many of these arguments are perhaps more easily applicable to the context of advanced, highly developed economies, I argue that the even the populations of lower-income (developing) societies have reasons to hold *generally* positive views of science. Over the past several decades, people in developing economies have also been increasingly benefiting from significant new developments in science, technology, and medicine. Life expectancy at birth, a common measure of human development, has increased dramatically in Sub-Saharan Africa—

improving from less than 45 years in 1970 to about 61 years in 2017 (World Bank 2019). Globalization is one of the main drivers of these changes. Modern hospitals, universities, and factories have been appearing in many agrarian societies, often with the help of foreign investors and corporations eager for high rates of return. Access to information about science is also more widely available today than ever before. According to a June 2019 report by the Council on Foreign Relations, there are now 525 million internet users in Africa, compared to about 447 million in Latin America and the Caribbean, and 328 million in North America (Campbell 2019).

Why and When the Cultural Authority of Science is Contested

The cultural authority of science is often contested in at least two types of situations. First, CAS is contested if scientific research and/or the guidance of scientists (indirectly) imposes an economic cost on prominent groups. Second, CAS is also contested if it is perceived as threatening the cultural authority of another institution. As noted by Gauchat (2012) and others, the rise of the "New Right" in the U.S. during the 1970s provides an illustration that combines elements from both of these cases. Between the 1940s and 1960s, there were few large-scale attempts to politicize (or undermine) the scientific community by either major party in the U.S. context. This is mainly due to the prestige enjoyed by scientists and scientific institutions during the period immediately following the Allied victory in World War II (Mooney 2006).

During the 1960s and 1970s, however, scientists and researchers were increasingly producing studies that linked human activity (e.g., manufacturing, the use of pesticides) and environmental degradation (e.g., Carson 1962; U.S. EPA 1972). These studies were indicating that various forms of pollution were not only destroying key natural resources (e.g., acid rain and deforestation), but that they were also very harmful to human health (e.g., carcinogenic air pollutants). Largely because of these studies and the efforts of environmentalist groups, the U.S. began passing many federal environmental laws during the 1970s and 1980s (Daynes and Sussman 2010; Portney 1990). Well-known examples of such federal legislation include the Clean Air Act (1970), Safe Drinking Water Act (1974), and the Nuclear Waste Policy Act (1982). The bill that became the Safe Drinking Water Act, for instance, was introduced in Congress after an EPA study in April 1972 found that the water in the Mississippi River contained many "…organic chemicals and toxic metals in high concentrations" (U.S. EPA 1972).

Largely in response to the rise of regulatory science, as well as major social and cultural changes, a new conservative movement known as the "New Right" (NR) emerged during the 1970s. The NR was a pragmatic political alliance between pro-business conservatives who wanted deregulation and religious social conservatives who were concerned about the "moral decline" of the country (e.g., rising levels of divorce, legalization of abortion). Pro-business conservatives and corporations wanted fewer regulations, but scientists often generated findings (e.g., on pollution and climate change) that were used in the halls of Congress to justify more regulation (Jasanoff 1990; McCright and Dunlap 2000, 2003; Otto 2016). On the other hand, religious conservatives felt threatened by the pro-Darwinian, pro-evolution beliefs of most scientists (AAAS 2006; Evans 2018). Religious conservatives also generally opposed stem cell research (which became politicized during the late 1990s/early 2000s) and other controversial research practices favored by many scientists (Blee and Creasap 2010; Evans 2018; Gross et al. 2011).

How is the Cultural Authority of Science Contested?

Contesting CAS often involves three common elements: first, crafting narratives aimed at undermining public trust in science; second, developing alternative sources of information ("alternative facts"); third, spreading these alternative narratives to the mass public. As an example, we can consider these three elements in the rise of the NR. First, many religious conservatives and pro-business conservatives accused scientific institutions and universities of harboring anti-religious and anti-conservative biases (Alumkal 2017; Jenkins and Shumate 1985; Mann and Schleifer 2020). Because scientists supposedly could not be objective, their findings could not be trusted—and by implication, their research should not guide the development of highly consequential public policies.

Conservative elites have also cultivated alternative sources of facts, statistics, and studies in response to what they perceived as the anti-conservative biases of liberal intellectuals in universities and research institutions (Blee et al. 2010; Gross et al. 2011; Nash 1988). In particular, elites in the NR have supported the establishment of conservative think tanks: the Heritage Foundation, American Enterprise Institute, Cato Institute, and Family Research Council are particularly well-known examples. These think tanks publish research briefs and policy memos that support deregulation (e.g., AEI, Cato) and/or socially conservative causes (e.g., FRC). Religious groups and donors have also supported the establishment of organizations that conduct research in “creation science” (Toumey 1994). Organizations such as Answers in Genesis, Creation Ministries International, Institute for Creation Research, and religious scientists have published books and other materials that seek to offer intelligent design as a credible alternative to Darwinian evolution in public and private schools (e.g., Brown 2008; Morris 2007).

Finally, the NR has relied on allied media outlets to help diffuse and popularize these alternative facts and alternative sources of expert knowledge (Gross et al. 2011; Jacques et al. 2008; Oreskes and Conway 2010). After all, it is not enough to simply create alternative facts and studies; they need to reach the intended audience: the mass public. In particular, the NR and its supporters have often been associated with cable networks including Fox News; conservative media figures such as Laura Ingraham, Sean Hannity, and Tucker Carlson; newspapers such as the *New York Post* and *The Washington Times*; and magazines including *National Review*, *The American Conservative*, and *The Washington Examiner*. Similarly, many evangelical Christians in the U.S. prefer to watch Christian TV shows (e.g., 700 Club) and TV networks such as the Trinity Broadcasting Network (TBN). Together, these politically and religiously conservative media outlets reach millions of Americans every day with news stories and alternative facts that support the conservative worldview.

Why Care if the Cultural Authority of Science is Contested?

Over the past few decades, a growing number of scholarly and journalistic accounts have documented the politicization of science (Evans 2013; Gauchat 2012, 2015; Lee 2021; McCright and Dunlap 2011; Mooney 2006; Otto 2016). Whether prominent social institutions and groups challenge the cultural authority of science, and to what extent these efforts succeed, are highly consequential questions. First, they have very serious practical implications. Public trust in science can affect the extent to which people are willing to believe scientific studies and findings. This is especially important when it comes to controversial scientific issues and debates: e.g., regarding climate change, vaccinations, stem cell research, and so on. For example, studies have shown that people who trust scientists are also more likely to trust scientific innovations such as biotechnology and gene editing (Brossard and Nisbet 2007; Olofsson et al. 2006; Priest et al. 2003). Conversely, distrust of science imposes high social and economic costs on society, which disproportionately affect disadvantaged communities: e.g., distrust in scientific guidelines on Covid-19 prevention, vaccine efficacy, climate change (environmental justice). Moreover, consider the implications of policymakers ignoring the best available social scientific evidence on homelessness, crime, education, immigration, and discrimination.

Second, the politicization of science by religious, political, or other forces has important implications for sociological theories (Gauchat 2012; O'Brien and Noy 2020; Sherkat 2017). Comte, Weber, and other classical theorists argued that as societies modernized, scientific knowledge would be prioritized ("rationalization of bureaucracy"). Moreover, Durkheim, Bruce (2011), and others argue that modernity also entails a significant decline in religiosity. Given these arguments, as well as the evidence supporting them, why is the cultural authority of science so fiercely (and successfully) contested in "modern" (wealthy) societies? Does this affect our understanding of how we define what constitutes a modern society? These questions generate related concerns of their own. For example, does the nature of the conflict between religion and science vary across countries, based on average levels of economic security?

Religion v. Science? Three Perspectives

In the social science literature, there are three major perspectives on the nature of the relationship between religion and science: independence ("separate domains") thesis, compatibility thesis; and conflict thesis. I briefly provide an overview of the general logic or intuition of each perspective before reviewing some recent evidence regarding these arguments.

(1) Independence

First, the independence ("separate domains") thesis suggests that religion and science are not fundamentally in conflict with one another because they primarily operate in different spheres of life (Ecklund et al. 2016; Evans 2018). This was a view popularized by historian of science Stephen J. Gould in his well-known essay, "Non-Overlapping Magisteria" (1997). That is, science focuses on discovering truths about the nature of the physical world; on the other hand, religion is charged with advancing normative prescriptions, morality, ethics; and searching for ways to provide meaning or a sense of purpose. A related view in philosophy is the idea that religion and science represent completely separate domains of knowledge; in a sense, this dichotomy is similar to the Cartesian idea of dualism (e.g., see Bermúdez 2005).

What both of these views have in common is the idea that religion and science maintain their own cultural boundaries and spheres of authority. Science has cultural authority over natural phenomena in the physical world; this means that scientists and scientific institutions have the power to examine and define physical objects and natural processes (Gieryn 1983, 1999). Natural and physical scientists give formal presentations, publish papers, and teach courses in physics, chemistry, biology, geology, and astronomy, for example. On the other hand, religion has cultural authority over the immaterial spiritual world: religious leaders and institutions speak on spiritual, moral, ethical, metaphysical, and philosophical matters (Christiano et al. 2008; Hamilton 2002).

(2) Compatibility

Second, some leading sociologists have argued that religion and science can and do share a mutually beneficial relationship—or that at the very least, they are compatible. This view was articulated in a review article by Evans and Evans (2008); also see Ecklund (2020). For example, Merton (1970, 1973) argued that some dominant cultural values of Protestant Christianity helped promote the rise and expansion of modern science and scientific institutions. These cultural values included a focus on empiricism with a specific motivation: the idea that exploring the natural world (e.g., through science) could "glorify God" by exposing the beauty and logic of creation. According to this narrative, until it established itself as an independent source of legitimacy, science benefited greatly from the mutually beneficial relationship it had with religion (Merton 1970; also see Shapin 1996). As an especially very powerful social institution during the 17th and 18th centuries, religion helped validate science and its allegedly pious (or "godly") aims.

Merton and other likeminded scholars focused on the link between Western religions (e.g., Christianity, Judaism) and science during the post-Enlightenment era. But other scholars have argued that scientific knowledge also proliferated in Islamic countries—as religious leaders and other Muslim elites sought to learn more about the physical world described in their religious texts (Freely 2010; Iqbal 2007; Saliba 2007). In this view, there was no necessary conflict between Islam and scientific progress, although some Islamic clerics and elites interpreted scientific knowledge in a way that would comport with their religious texts and traditions (Sardar 1989). More recently, the compatibility thesis has been supported by findings from both qualitative research involving in-depth interviews (Vaidyanathan et al. 2016); as well as from quantitative studies that have identified latent classes with favorable views toward both religion and science (DiMaggio et al. 2018; O'Brien and Noy 2015).

(3) Conflict

Third, some empirical studies in the literature assume that there is at least some sort of a conflict between religion and science (Baker et al. 2020; Cacciatore et al. 2018; Gauchat 2012, 2015; O'Brien and Noy 2015). These conflicts tend to be epistemological, concerning truth claims about objective matters (e.g., human evolution, origins of the universe); or moral in nature, involving subjective questions such as the morality of human embryonic stem cell research. Until recently most scholarship on the conflict thesis focused on perceived epistemological conflicts (e.g., see Evans 2018). According to a strong form of the epistemological conflict narrative, conflicts between religion and science are inevitable because the fundamental ontological and epistemological underpinnings of these systems necessarily contradict each other. That is, religion and science are in conflict because they fundamentally disagree about the nature of reality and how knowledge is acquired.

For example, according to some accounts, the ontology of religion presumes the existence of a creator, deity, or some other higher power(s); it also generally professes belief in a supernatural world and the possibility of miracles (Moore and Scott 2007; Tillich 1955). By implication, the epistemology of religion assumes that knowledge about the nature of reality and life come from religious texts and/or divine revelation; to acquire this knowledge, one should study religious texts, seek divine revelation, and seek the counsel of religious leaders who have received appropriate training. In contrast, the ontology of science is based on naturalism, or the belief in a natural world that operates in accordance with a fixed set of laws and axioms (Maturana 1990); it is agnostic on the nature of a deity. Since the laws of nature (e.g., in physics or chemistry) are stable, they are predictable and can be examined in a controlled and systematic way. The epistemological position of science prizes empiricism, logic, and positivism (Harré 1985; Rosenberg 2011). In this view, knowledge is created—and periodically revised—by employing the scientific method: the development of theories, data collection, hypothesis testing, and statistical inference (Gower 1997).

Some scientists have publicly embraced the strong form of the conflict narrative, publishing best-selling books arguing that religion and science are inherently incompatible (e.g., see Coyne 2015; Dawkins 2006, 2015; Harris 2004, 2010; Krauss 2012). For example, the prominent evolutionary biologist Richard Dawkins, in “The God Delusion,” argues that many religions consider their favored truths to be totally impervious to the discovery of disconfirming evidence or data. Religion is in this sense, completely antithetical to the enterprise of science.

A Roadmap of the Three Empirical Papers (Chapters 2-4)

As noted earlier, the first empirical paper develops and tests a new religio-political framework for studying the cultural authority of science in the U.S. context. The logic underlying the proposed approach is that to better understand the nature of polarization in beliefs about science, we can measure deviations of key groups (e.g., literalist Democrats, secular Republicans) from the same theoretically-determined reference group: secular independents. The next two papers use data from the World Values Survey (WVS) to study the link between religious identity and the cultural authority of science in cross-national contexts. In particular, my second empirical paper seeks to measure and predict cross-national variations in distinct religio-scientific perspectives (e.g., modernist, post-secularist). In my third empirical paper, I examine the extent to which general science attitudes, religiosity, and religious exclusivism shape people’s views about conflicts between religion and science—and which side they would support when conflicts emerge.

Chapter 2: Protestant Biblical Literalists in the U.S. Differ Significantly by Party in Their Science Beliefs

Abstract:

Research has shown that certain religious groups such as Protestant biblical literalists are less likely to trust scientists and accept specific scientific findings (e.g., human evolution). However, to what extent do Democrats and Republicans within these religious groups differ in their science beliefs? This paper develops a new religio-political framework for studying the cultural authority of science, and then tests it using data from the General Social Survey. The results show that there is significant heterogeneity within religious groups, especially among Protestant literalists. Study 1 (n = 19,761) demonstrates that since the mid-1980s, trust in scientists has declined among Protestant literalists, Protestant nonliteralists, and Catholics who are Republicans, but not among those who are Democrats. Similarly, Study 2 (n = 5,850) shows that while both Democratic and Republican Protestant literalists are less likely to accept human evolution and the Big Bang, the impact of literalism is substantially greater among Republicans.

Keywords: religion, science, politicization of science, public opinion

Introduction

Over the past few decades, there has been a significant growth in research on the link between religious identity, party affiliation, and science attitudes (Ecklund and Scheitle 2017; Evans 2013, 2018; Johnson et al. 2015; O'Brien and Noy 2020). For example, a prominent area of interest concerns the politicization of science in the U.S., which has been documented by both scholarly (e.g., Evans 2013; Lee 2021; Gauchat 2012; McCright and Dunlap 2011) and journalistic accounts (e.g., Mooney 2006; Otto 2016). The politicization of science occurs when individuals or groups attempt to undermine public trust in the validity of scientific research for political purposes (e.g., blocking legislation that would reduce pollution).

Some analysts have argued that both political and religious leaders are responsible for politicizing scientific institutions and research, as evidenced by the significant partisan and religious divides in beliefs about the trustworthiness of science. For example, existing studies have shown that trust in scientists has declined among ideological and religious conservatives (Evans 2013; Gauchat 2012; Mann and Schleifer 2020); and on specific scientific issues, ideological conservatives are less willing to acknowledge human contributions to global climate change (McCright and Dunlap 2011), while religious conservatives are less willing to accept human evolution and the Big Bang (Drummond and Fischhoff 2017; Jelen and Lockett 2014).

However, a key limitation in this literature is that the predictive effects of religious identity and party affiliation are modeled separately. According to national polls, over 60% of U.S. adults identify as Protestants or Catholics; and most of them attend religious services or pray at least somewhat regularly (Pew Research Center 2019; also see Tables A1 and A2 in the

Supplementary Materials). To what extent do beliefs about the trustworthiness of scientific research and mainstream scientific institutions vary within major religious groups, based on party affiliation? For example, do Protestant literalists who are also Democrats think about science similarly as Republican Protestant literalists? This important question has not been adequately addressed in the literature, even though it has numerous implications for society. To effectively counter the politicization of science, researchers must better understand its origins and nature.

This paper makes two contributions to the literature. First, I briefly review recent historical evidence to demonstrate that there are reasons to expect significant partisan divides within certain religious groups when it comes to trust in science. These observations are summarized in a new "religio-political framework," which proposes measuring variations within religious groups by comparing these subgroups to the same reference category (Johfre and Freese 2021): secular independents. Second, using data from the GSS, I empirically test predictions generated by this framework.

In Study 1, I assess group-specific trends in public confidence in the mainstream scientific community (Evans 2013; Gauchat 2012; Lee 2021; O'Brien and Noy 2020). A common assumption is that trust in science has declined broadly among Protestant literalists since the 1980s; yet when disaggregated by party, the results in Study 1 show that this only applies to Republicans. In Study 2, I use the framework to generate additional hypotheses related to the polarization of public beliefs about specific contested scientific issues (Drummond and Fischhoff 2017; Jelen and Lockett 2014). These studies tend to find that certain religious groups are less supportive of human evolution, the Big Bang, and human embryonic stem cell research;

however, the results in Study 2 indicate that in many cases, religious Democrats are actually similar to secular independents in their views, whereas it is religious Republicans (especially Protestant literalists) who deviate significantly from this reference group. In sum, the results based on the religio-political framework in both Studies 1 and 2 provide new insights about the nature of mass polarization in beliefs about the authority of science.

A New Religio-Political Framework

Social identity theory suggests that people often have multiple social identities (e.g., gender, race/ethnicity) and that the relative salience of each identity can vary based on the situation at hand (Burke and Stets 2009). In this context, there are two particularly salient social identities: religion and political party. This is based on the idea that elites in both political parties and religious groups have been communicating claims that either support or challenge the cultural authority of science.

Politicization of Science among Religious Groups

The religious landscape in the U.S. is highly fragmented, reflecting a rich diversity of religious beliefs, traditions, and institutions (e.g., for the well-known RELTRAD classification system, see Evans 2013, 2018). However, when it comes to politicizing the cultural authority of science, I argue that there are four large theoretically important groups: conservative Protestants, who have received negative elite messaging about the trustworthiness of the mainstream scientific community since the 1980s; Catholics, who have received mixed elite messaging during this period; moderate/liberal Protestants, who have received positive or neutral messaging about science; and secular individuals, who mostly have not been subject to any comparable type of elite messaging, since the vast majority are not formally members of secular groups (e.g., American Humanist Association; see Niose 2012). Currently, the framework does not account for members of small religious groups (e.g., Hinduism, Islam, Judaism) because they collectively constitute only about 5-6% of the U.S population (Evans 2018). I will briefly review the evidence for these arguments in order of the main groups listed.

In this framework, what distinguishes a conservative Protestant from a moderate/liberal Protestant is not their membership in any particular denomination per se, because denominations are themselves internally quite heterogeneous (Alumkal 2017). Instead, it is whether the Protestant espouses biblical literalism, a doctrine with implications for their beliefs about science (Evans 2013, 2018). Biblical literalists are more likely to attend local churches with pastors who teach a literal interpretation of the book of Genesis (e.g., that "God created humans in their present form"); the reverse is often the case among nonliteralists, who favor more flexible or metaphorical interpretations of the bible. These groups are often referred to as conservative and moderate/liberal Protestants, respectively.

In the U.S. context, Protestant literalists are disproportionately (but not exclusively) drawn from those who attend churches in evangelical denominations such as the Southern Baptist Convention (Alumkal 2017). Protestant literalists are more likely to have both moral conflicts and what Evans (2018) calls "propositional belief conflicts" with the mainstream scientific community. Propositional belief conflicts refer to the idea that while conservative

Protestants do not have a problem with the scientific method per se, many reject a few specific, well-established scientific theories (i.e., human evolution, Big Bang), because the theories are perceived as conflicting with their more literal interpretations of the bible (Masci 2019). However, these propositional belief conflicts between Protestant literalists and the scientific community are not new. They have existed since at least the early 20th century, as exemplified by the highly contentious fundamentalist-modernist debates among Protestants of the time. During the late 1970s and early 1980s, prominent fundamentalist pastors and leaders such as Jerry Falwell mobilized conservative Christians to support the Republican Party (Wilcox and Robinson 2010). As argued by Alumkal (2017) and others, leaders in this religio-political movement did not just target the Democratic Party; they also accused scientists and other cultural elites of spreading anti-Christian values and promoting atheism.

In contrast, moderate or liberal Protestants, who reject biblical literalism, are more likely to attend churches in mainline Protestant denominations such as the United Methodist Church, the Presbyterian Church (USA), and the Episcopal Church. Since the early 20th century, progressive theologians have argued that interpretations of the bible should evolve in light of scientific developments and findings; as such, they have not publicly attacked or sought to undermine the mainstream scientific community (Evans 2018). Moreover, many pastors and leaders in moderate or liberal Protestant groups have been quite supportive of (or at least neutral on) human embryonic stem cell research, suggesting that there have been no consistently negative messages about moral or propositional conflicts between religion and science (Pew Research Center 2008).

In contrast, many Catholics have moral but not propositional (or epistemological) conflicts with science. In the modern era, the Catholic Church has generally not explicitly rejected or attacked scientific findings. Indeed, in 2014, Pope Francis expressed his belief that the conclusions of scientists on human evolution are not necessarily incompatible with the bible; his statements reflect the sentiment that is common among many Western Catholic elites in recent history (Tharoor 2014). While most Catholics do not receive consistent negative elite messaging related to the credibility of specific scientific findings (e.g., human evolution), many have been exposed to contemporary moral concerns related to bioethics and human embryonic stem cell research. Moreover, these moral conflicts did not become salient until around the 1990s and early 2000s, when scientific innovations enabled researchers to extract stem cells from human embryos. For example, the Catholic Church and many of its leading theologians have argued that human embryonic stem cell research is tantamount to the intentional ending of a human life; in their view, such research thus violates the teachings of Christian scripture (U.S. Conference of Catholic Bishops 2008).

What about secular Americans? According to a recent Pew study, about 26% of U.S. adults self-identify as atheists, agnostics, or unaffiliated with any religion (Pew Research Center 2019; Niose 2012). When we account for non-observant, or only nominally affiliated members of religious groups, the true proportion of secular adults is significantly greater. However, although there are a few national organizations or advocacy groups for atheists and agnostics (e.g., American Atheists, Freedom from Religion Foundation), they typically have thousands or tens of thousands of members. That is, while tens of millions of Americans consider themselves to be nonreligious or unaffiliated, the vast majority of them do not belong to any particular group for disbelievers. As such, there is no reason to believe that secular Americans in the mass public are receiving elite messaging on a large scale that that is comparable to what has been occurring among Protestant literalists, and to a lesser extent, among Catholics and Protestant nonliteralists.

Politicization of Science among Political Parties

During the late 1970s and early 1980s, a new coalition of pro-business conservatives and socially conservative religious voters became highly influential within the Republican Party (Mooney 2007). Some scholars have referred to this conservative coalition as the “New Right” (e.g., Gauchat 2012). During the administrations of Reagan and (especially) George W. Bush, the Republican Party increasingly took positions on key issues that placed the party at odds with established scientific knowledge: e.g., by appointing those who denied global climate change and/or supported intelligent design to key leadership roles in the White House or in federal agencies (Alumkal 2017; Oreskes and Conway 2010; Otto 2016). Moreover, many prominent Republican leaders and their conservative allies argued that scientists at leading research institutions were overwhelmingly ideologically liberal—and thus biased against Republicans and conservative causes (Mooney 2006). By implication, the research produced by scientists (e.g., on global climate change) were allegedly based on personal agendas and thus simply not reliable.

Industry groups and other pro-free market conservatives helped establish many ideologically conservative think tanks. A few notable examples include the Cato Institute, Heritage Foundation, Hudson Institute, and Manhattan Institute (Dunlap and Jacques 2013; Medvetz 2012). By providing “alternative facts,” these partisan centers of knowledge provide intellectual cover for conservative elites who argue that the scientists producing studies on topics like climate change or stem cell research do so because they are trying to advance their own agendas—not because of the science, per se (Mann and Schleifer 2020).

On the other hand, Democratic elites have also been spreading messages about the cultural authority of science. In particular, since the 1970s, Democrats in Congress and party leaders have argued that science provides a legitimate basis for policy-making, especially (but not exclusively) on protecting the environment (e.g., Gore 1992, 2006; Verhovek 2020). These themes are often embedded in the official Democratic Party platforms, which are widely publicized during each presidential election cycle and can influence legislative priorities. For example, in 1984, former Vice President Walter Mondale received the Democratic Party's nomination for president. That year, the Democrats once again adopted a party platform that called for federal policies to be guided by scientific research in domains as diverse as educational programming on TV and defense policy (UC Santa Barbara 1984). Implicit in such statements is the idea that scientific research provides a credible basis for designing highly consequential government programs, regulations, and policies that affect the lives of hundreds of millions of people (Jasanoff 1990; Oreskes 2019).

During the 1990s and 2000s, Al Gore and other leading Democrats urged Congress to respect the scientific evidence on climate change and strengthen regulations (Gore 1992, 2006). More recently, high-profile Democrats including President Joe Biden, House Speaker Nancy Pelosi, and Senate Majority Leader Chuck Schumer, have advised the public to follow scientific guidance in order to slow the spread of Covid-19 (Verhovek 2020). A recent study provides additional support for this two-sided polarization thesis: Lee (2021) shows that since the 1970s, party polarization increased because Democrats became more likely to have high confidence in science, whereas Republicans became less likely to have high confidence.

In sum, an individual's affiliation with a religious group and political party are both assumed to be salient social identities when it comes to beliefs about the scientific community and scientific research (Burke and Stets 2009). Thus, there are eight partisan religio-political groups of interest: Protestant literalist Democrats, Protestant nonliteralist Democrats, Catholic Democrats, secular Democrats, Protestant literalist Republicans, Protestant nonliteralist Republicans, Catholic Republicans, and secular Republicans. In this context, secular independents are an appropriate reference group, since they are less subject to the politicizing influences of political or religious groups (Johfre and Freese 2021). Table 1 below provides a summary of this discussion: "RL" stands for messaging from religious leaders, "PL" stands for messaging from political leaders. As with most social scientific constructs, these categorizations are broad generalizations, based on a subjective review of the available historical and empirical literature.

Table 1: Religio-Political Framework

	Democrat	Republican
Protestant literalist	RL: Propositional and moral conflicts PL: Positive messaging	RL: Propositional and moral conflicts PL: Negative messaging
Protestant nonliteralist	RL: No conflicts PL: Positive messaging	RL: No conflicts PL: Negative messaging
Catholic	RL: Only moral conflicts PL: Positive messaging	RL: Only moral conflicts PL: Negative messaging
Secular	RL: Not applicable PL: Positive messaging	RL: Not applicable PL: Negative messaging

In Studies 1 and 2, I generate specific predictions using this religio-political framework, which are then tested using data from the General Social Survey (GSS).

Study 1: Group-specific Trends in Confidence in Science

Background

Study 1 addresses whether levels of trust in the mainstream scientific community among religio-political groups have changed since the 1980s. Using the "confidence in institutions" question series from the GSS, many researchers have examined this question in various ways (Evans 2013; Gauchat 2012; Lee 2021; O'Brien and Noy 2020). The earliest and most influential of these papers, Gauchat (2012), found that trust in science remained relatively stable between 1974-2010 for most groups, but declined among ideological conservatives and those who regularly attend religious services. Subsequently, Evans (2013) demonstrated that the decline in trust among religious Americans was actually concentrated among biblical literalists who attend churches in conservative Protestant denominations. Using more recent data, Lee (2021) shows that trust in science has also declined among Catholics since the 1990s and among moderate/liberal Protestants since the 2000s.

These findings are certainly important but do not address an important question: are these trends among religious groups (equally) true among both Democrats and Republicans? As demonstrated by the new religio-political framework, there are theoretical reasons to believe that the politicizing influences of religious leaders may vary quite significantly based on party affiliation.

Hypotheses

Based on the previous review, I argue that we can infer predicted trends in trust in science for each of these religio-political groups. In particular, public confidence in scientists is expected to have declined for all four groups of Republicans, because all of them would have been subject to the negative politicizing influences of party leaders, religious leaders, or both; moreover, none of these Republican groups would have consistently received contradictory (i.e., pro-science) messaging from either party or religious leaders.

In contrast, public confidence in science is expected to remain relatively unchanged among Catholic and Protestant literalist Democrats, because while they received pro-science messaging from party leaders, they would have also been exposed to anti-science messaging from religious leaders (Table 1). The intuition here is that the contradictory messages may cancel each other out; this type of effect has been observed in studies of opposing frames (e.g., Chong and Druckman 2007). However, confidence in science is expected to have increased over time among secular and Protestant nonliteralist Democrats, who would have mostly only received the pro-science messaging from party elites and no contradictory messaging from religious leaders. The predictions that involve changes over time are stated below as hypotheses:

> Hypothesis 1: Trust in scientists has declined among all four Republican groups (relative to secular independents)

Hypothesis 2: Trust in scientists has increased among secular and Protestant nonliteralist Democrats (relative to secular independents)

Data

In Study 1, I use repeating cross-sectional data from the General Social Survey (1984-2018; Smith et al. 2018). The GSS is a well-known nationally representative survey that is regularly fielded by the National Opinion Research Center (NORC) at the University of Chicago. While the GSS began its surveys in 1972, the key bible views item is only available starting in 1984.

Dependent variable. The GSS asks respondents to indicate how much confidence they have in the leaders of many institutions, including scientific communities. There are four possible responses: "great deal of confidence," "only some confidence," "hardly any confidence at all," and "don't know." Responses for the scientific communities item were recoded to create a binary outcome: 1 = great deal of confidence; 0 = not a great deal of confidence (e.g., see Gauchat 2012; Evans 2013; Lee 2021). Binary coding is used so that the results are comparable with those of existing studies and because using a 1-3 numeric scale would have required excluding a large number of cases (i.e., those selecting "Don't know").

Religio-political groups. There are eight religio-political groups and one reference group (secular independents). First, a new variable was created for religion using respondent answers to the GSS religious group ("relig"), bible views ("bible"), and religious attendance variables ("attend"). Those who self-identify as Protestant, favoring literal interpretations of the bible, and attending services at least once a month are coded as active Protestant literalists. Those who meet only the first two criteria are coded as active Protestant nonliteralists. Those who identify as Catholic and attend services at least once a month are coded as active Catholics. Finally, those who are either religiously unaffiliated or attend services only several times a year or less often and hold nonliteralist beliefs are coded as secular (for more details, see Appendix A). Using the new religion and party ID variables, all respondents are coded as belonging to one of the eight religio-political groups (Table 1), secular independents (reference group), and other. The heterogeneous "Other" group, which is beyond the scope of this study, includes: e.g., religious independents, partisans who belong to one of the smaller religious groups (Buddhism, Hinduism, Islam, Judaism).

Control variables. Following existing studies in this literature, the models control for relevant demographic and socioeconomic covariates: age, age squared, gender, race/ethnicity, generation (based on birth year, see Carlson 2009), educational attainment (years), household income (in constant dollars and logged), rural, and South (e.g., see Gauchat 2012; Lee 2021; O'Brien and Noy 2020). In addition, I also control for high confidence in medicine, since trust in science might be correlated with trust in expert institutions more generally.

Methods

I estimated a binary logistic regression predicting whether respondents have high confidence in science (1 = yes) as a function of membership in a religio-political group and the controls described above. To assess whether the differences between a partisan religio-political group and the reference group (secular independents) change over time, I included an interaction term between year and each religio-political group. Since the coefficients produced by logistic regression models are difficult to interpret, particularly for interaction terms, the results are presented as average marginal effects (Mood 2010): here, AMEs refer to the average predictive effects of membership in a particular partisan group (relative to the reference group) net of covariates. The outcome of interest is the extent to which the AME for a particular religio-political group (e.g., Protestant literalist Republicans) changes over time.

Study 1 included data from 19,761 respondents; for sample summary statistics, see Table A1, Supplementary Materials. In both Studies 1 and 2, the final analytic samples only include cases with complete data on the variables used. The recommended GSS sampling weights are used ("wtssall") for all the analyses in the main text (for unweighted results, which are similar, see Figures A1 and A2, Supplementary Materials).

Results

The results of the binary logistic regressions are displayed in Table 2, and the corresponding AMEs are displayed in Figure 1. As predicted by Hypothesis 1, the AMEs among all Republican groups significantly declined between 1984-2018, as evidenced by the statistically significant negative interaction terms between the Republican groups and year (Table 2). In 1984, Protestant literalist Republicans were almost identical to secular independents (reference group) in their likelihood of having high confidence in scientists (net of covariates); however, by 2018, Protestant literalist Republicans were about 19 percentage points less likely to have high confidence. In 1984, the three other groups of Republicans were at least as likely as secular independents to have high confidence in scientists; however, by 2018, the probability of having high confidence in scientists declined by 13 to 16 percentage points among Catholic, Protestant nonliteralist, and secular Republicans (compared to the reference group, net of covariates).

In contrast, the results show that the likelihood of having high confidence in scientists has neither significantly increased nor decreased among the four Democratic groups (compared to secular independents). The point estimates for changes in the AMEs for Democrats between 1984 and 2018 are much smaller, and the interaction terms for the Democratic groups and year are not statistically significant. In this sense, the predictions of the religio-framework for the trends among Democratic groups are only partially supported by the results. As expected, there are no significant changes over time among Catholic and Protestant literalist Democrats, who have likely been subject to competing messages by religious and political leaders. However, the predicted increase in trust among Protestant nonliteralist and secular Democrats, stated in Hypothesis 2, did not materialize.

Overall, the results show that there is significant evidence of heterogeneity in trends within each religious group, with high confidence in scientists only having declined among religious Republicans—and not among their Democratic counterparts. That is, any aggregate changes among religious groups appear to be driven by a specific partisan subset of the groups, and are not broadly applicable.

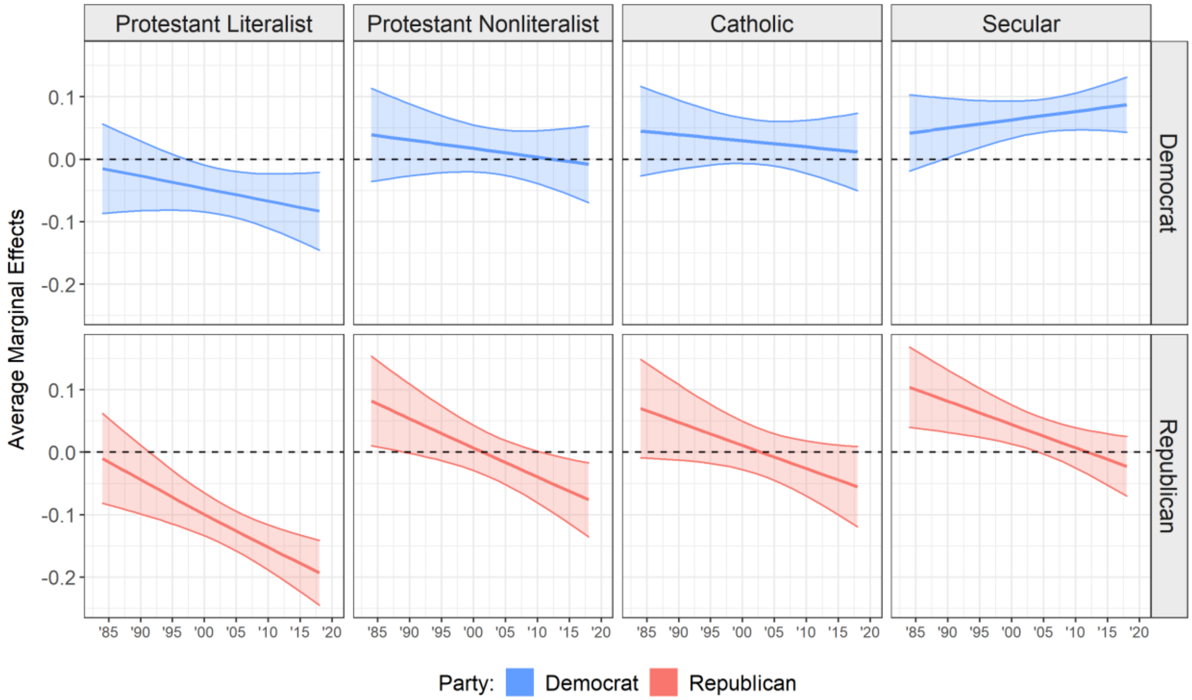
Table 2: Binary Logistic Regressions Predicting High Confidence in Scientists (Weighted)

	Outcome: High Confidence in Scientific Community
Religio-Political Group (ref. Secular Indep.)	

Democratic Protestant Literalist	19.56 (16.98)
Democratic Protestant Nonliteralist	13.55 (16.86)
Democratic Catholic	9.77 (16.58)
Democratic Secular	-11.80 (13.25)
Republican Protestant Literalist	57.32*** (16.68)
Republican Protestant Nonliteralist	45.45** (16.43)
Republican Catholic	35.94* (18.02)
Republican Secular	36.08* (14.08)
Year	0.01 (0.01)
Group-year interactions	
Dem. Protestant Literalist * year	-0.01 (0.01)
Dem. Protestant Nonliteralist * year	-0.01 (0.01)
Dem. Catholic * year	-0.005 (0.01)
Dem. Secular * year	0.01 (0.01)
Rep. Protestant Literalist * year	-0.03*** (0.01)
Rep. Protestant Nonliteralist * year	-0.02** (0.01)
Rep. Catholic * year	-0.02* (0.01)
Rep. Secular * year	-0.02* (0.01)
Education (years)	0.11*** (0.01)
Household income (real, logged)	0.10*** (0.02)
South	-0.05 (0.03)
Rural	-0.13** (0.05)
High Confidence in Medicine	1.34*** (0.03)
Observations	19,761
Log Likelihood	-11,758.84
Akaike Inf. Crit.	23,587.68

Source: General Social Survey, 1984-2018 (n = 19,761); GSS weight variable: "wtssall"
*Notes: Unstandardized regression coefficients (standard errors in parentheses). Other controls include age, age squared, birth cohort (generation), gender, race/ethnicity. Coefficient for "Other" religio-political group not displayed. Statistical significance (two-tailed): *p<0.05; **p<0.01; ***p<0.001*

Figure 1: Average Marginal Effects of Religio-Political Group on Trust in Scientists (Weighted)



Source: General Social Survey, 1984-2018 (n = 19,761); GSS weight variable: "wtssall"
Note: AMEs are based on the binary logistic regression models in Table 2; 95% confidence intervals displayed

Study 2: Beliefs about Contested Scientific Issues

Background

In Study 1, I applied the new religio-political framework to examine intra-group heterogeneity in a more generalized form of trust in science (Oreskes 2019). Next, I turn to another active area of research on the cultural authority of science: beliefs about specific scientific issues that are contested in the public sphere, such as human evolution, the Big Bang, and human embryonic stem cell research. This is an important topic because it concerns issues where the mainstream scientific community and certain major religious groups have explicit disagreements; thus, the cultural authority of one institution is in direct competition with that of the other (Alumkal 2017; Gieryn 1999; Oreskes 2019).

Contrary to public perception, research shows that religious people generally do not have less interest in science or lower levels of scientific literacy (Ecklund and Scheitle 2017; Johnson et al. 2015). Instead, members of certain religious groups are more likely to disagree with the scientific consensus on a limited number of specific issues where they have received opposing elite messaging (Masci 2019). For example, in a well-known 2017 paper published in the *PNAS*, Drummond and Fischhoff (2017) show that religious fundamentalists are significantly more likely to reject human evolution and the Big Bang, but not more likely to oppose the scientific community on whether it is safe to eat genetically modified foods or the relative merits of nanotechnology. Similarly, Jelen and Lockett (2014) find that biblical literalism strongly predicts opposition to human evolution and government funding of human embryonic stem cell research, but not opposition to climate science (which has been politicized by Republican elites, but not by religious elites).

Ultimately, while these studies are insightful, they do not consider whether the predictive effects of membership in certain religious groups vary among Democrats and Republicans. Yet this approach imposes a rather strong assumption of within-group homogeneity that may not be realistic. Do the conclusions that are widely cited in this literature change if a more flexible approach is used?

Hypotheses

The religio-political framework proposed in this paper (Table 1) is broadly applicable and generates useful predictions for this area of research as well. To illustrate, I use the framework to examine the expected beliefs of each religio-political group (relative to secular independents) on three of the science issues examined by Drummond and Fischhoff (2017): human evolution, Big Bang, and human embryonic stem cell research (HESCR). These issues offer a good test of the theoretical arguments presented in this paper, because they have been subject to messaging by religious and political leaders (primarily the former).

First, when it comes to human evolution, the Big Bang, and HESCR, Protestant literalists regardless of party are expected to express greater opposition than secular independents; however, the opposition is likely even stronger among Protestant literalists who are also Republicans. The intuition is that Protestant literalists are much more likely to attend churches that espouse biblical literalism and are socially conservative; as such, they are much more likely to hear their religious leaders promote literal interpretations of the creation story in Genesis, as well as express opposition to abortion access, marriage equality, and HESCR (Alumkal 2017; Masci 2019). However, whereas Republicans may receive similar messaging from prominent members of their party, this is not the case with Democrats (Mooney 2006). The list of prominent Republicans who have openly rejected human evolution include, for example, multiple Republican presidential candidates from the past several cycles alone (e.g., Alumkal 2017; Otto 2016). Thus, among Republicans, there may be a "reinforcing effect," which amplifies the politicizing influences of elites on these specific issues.

Since both Catholics and Protestant literalists presumably do not (generally) have propositional conflicts with science, these religious groups are not expected to differ significantly from secular independents on human evolution or the Big Bang. However, Catholics and Protestant literalists differ in that the former are more likely to experience moral conflicts with science, due to messaging from Catholic leaders on issues like abortion and HESCR. The framework would suggest in this case that Catholic Republicans would be more likely to oppose HESCR, since they receive negative messaging on HESCR from both political and religious leaders; on the other hand, Catholic Democrats are expected to be not significantly different from the reference group, since they receive contradictory messaging from religious and political leaders. For example, during the administration of George W. Bush, Congressional Democrats sought to liberalize rules governing the use of human embryonic stem cells for scientific research (Tanne 2007).

Accordingly, where significant group differences are predicted, they are summarized as hypotheses below:

> Hypothesis 1: On human evolution, Big Bang, and government funding of human embryonic stem cell research: (a) all Protestant literalists are less likely to accept/support than secular independents, (b) but this pattern is even stronger among Republicans.
>
> Hypothesis 2: On government funding of HESCR: among Catholics, Republicans are consistently less likely to support.

Data

Dependent variables. Following the 2017 *PNAS* paper by Drummond and Fischhoff (2017), I use data from the GSS. Starting in 2006, the GSS began asking a more detailed set of questions that measured people's scientific knowledge and beliefs about specific scientific issues. For a few outcomes, only a binary coding makes sense substantively and theoretically (e.g., on human evolution and the Big Bang, respondents can either answer the question correctly or not); for the other outcome, the respondent answers can be converted into a continuous scale. However, to compare the predictive effects of group membership across these outcomes, all outcomes are converted into binary variables. In particular, responses supporting the scientific consensus on an issue or the public funding of scientific research are coded as a 1 (e.g., Drummond and Fischhoff 2017).

To measure beliefs about human evolution, I used respondent answers to the following question: "Human beings, as we know them today, developed from earlier species of animals. (Is that true or false?)" Similarly, to measure beliefs about the Big Bang, I used respondent answers to the following question: "The universe began with a huge explosion. (Is that true or false?)" For both questions, a response of "True" was coded as a 1, while "False" and "Don't know" were coded as 0. The third outcome indicates whether respondents believe the government should fund human embryonic stem cell research. Responses indicating that the government should probably or definitely fund the research were coded as a 1, while other responses were coded as a 0 (i.e., "Don't know," or probably/definitely should not fund).

Control variables. The controls used in Study 2 are very similar to those of Study 1, with a few exceptions. First, I do not include confidence in medicine as a control, because the outcomes here are beliefs about specific scientific issues, not a generalized form of confidence in the scientific community (which is an expert institution like medicine). In addition, the confidence in medicine item did not always appear in the same surveys as all three outcomes. Second, a new control was added, because it is a well-known correlate of science attitudes: scientific knowledge. To measure scientific knowledge, I created a 9-point index, where higher values denote more scientific knowledge (e.g., Drummond and Fischhoff 2017). Since 2006, the GSS has frequently asked questions that assess respondents' level of scientific knowledge. For example, respondents are asked relatively easy questions such as whether "the center of earth is very hot"; as well as comparatively more challenging questions such as whether "lasers work by focusing sound waves." For each question that is answered correctly, the respondent receives an additional point on this index; 9 points indicates that the respondent answered all 9 questions correctly.

Methods

To assess the predictions, I estimated binary logistic regression models that predicted these science beliefs as a function of membership in the religio-political groups and the covariates described above. Again, average marginal effects are displayed to show effect sizes in more intuitive terms (Mood 2010). In Study 2, the analyses used data from 5,850 unique respondents, although the sample size varied by model/outcome based on data availability. For sample summary statistics, see Table A2, Supplementary Materials.

Results

The results of the analyses are presented in Table 3 and partisan differences in AMEs are displayed by religious group and scientific issue in Figure 2. First, the results are generally consistent with the predictions made in Hypothesis 1a: i.e., regardless of party, all Protestant literalists are significantly less likely to accept (or support) human evolution, the Big Bang, and federal funding of HESCR (relative to secular independents); the one exception is that Protestant literalist Democrats are similar to secular independents in their support for HESCR. Moreover, as predicted by Hypothesis 1b, although all Protestant literalists are less likely to accept human evolution and the Big Bang, this pattern is far stronger among Republicans. For example, Protestant literalist Democrats are 28 percentage points less likely to accept human evolution, but Republican fundamentalists are 51 percentage points less likely to accept it (net of covariates, relative to secular independents). On the Big Bang, the AMEs are -16 and -29 percentage points, respectively. On government funding of HESCR, the partisan differences among Protestant literalists are even more significant: Democrats are actually similar to secular independents, whereas Republicans 51 percentage points less likely to support it.

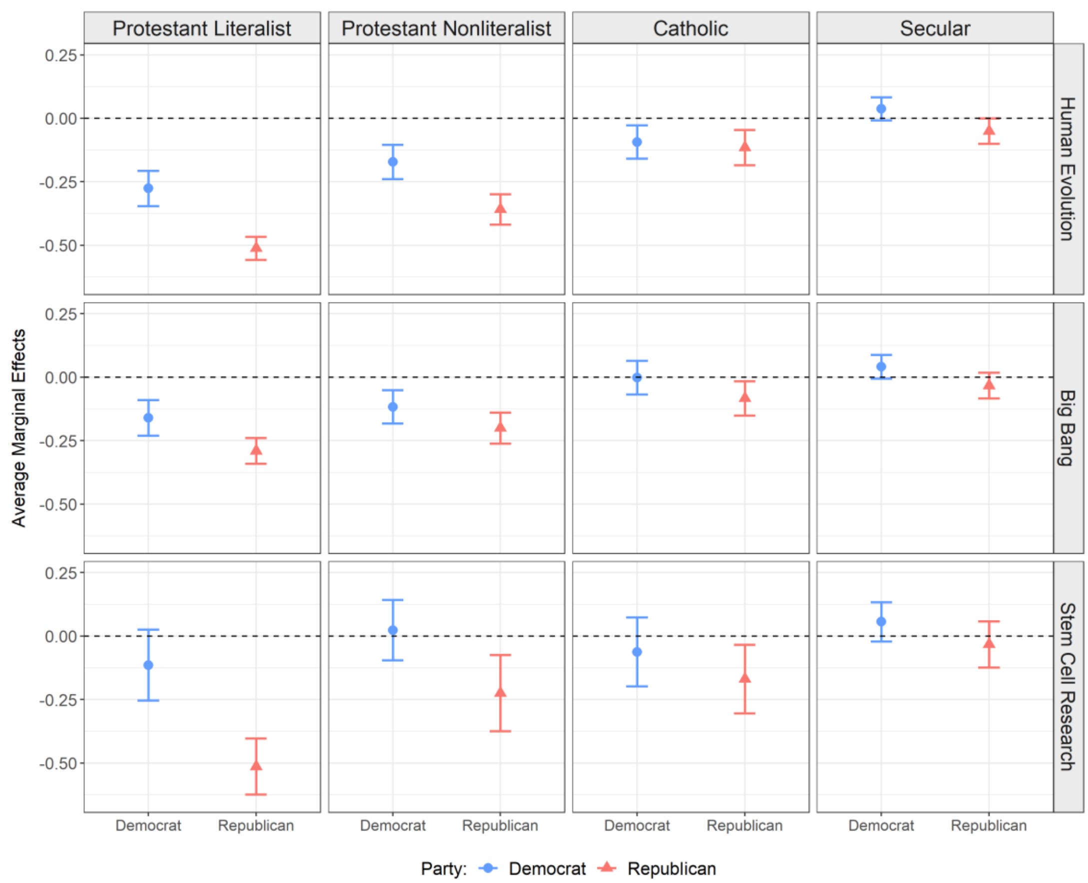
In addition, as predicted by Hypothesis 2, among Catholics, only Republicans are significantly less likely to support government funding of HESCR than secular independents (by about 17 percentage points). While the main hypotheses were generally supported by the results, the evidence offers less support for the predictions of no significant group differences (or null hypotheses). For example, because they generally lack propositional (epistemological) conflicts with science, both Catholics and Protestant nonliteralists were expected to not differ significantly from secular independents on either human evolution or the Big Bang. However, both partisan subsets of these two religious groups were significantly less likely to accept the human evolution and the Big Bang, with one exception being Democratic Catholics, who were similar to secular independents on the Big Bang. In addition, since Protestant nonliteralists generally do not have moral conflicts with science, they were also expected to be similar to secular independents in their views on government funding of HESCR. However, while this was indeed the case among Democrats, Protestant nonliteralists who are Republicans were 23 percentage points less likely to support public funding of HESCR.

Table 3: Binary Logistic Regressions Predicting Science Beliefs (Weighted)

	Dependent variable:		
	(1) Evolution	(2) Big Bang	(3) Funding HESCR
Religio-Political Group (ref. Secular Indep.)			
Democratic Protestant Literalist	-1.26^{***} (0.17)	-0.79^{***} (0.19)	-0.66 (0.39)
Democratic Protestant Nonliteralist	-0.77^{***} (0.16)	-0.56^{***} (0.17)	0.17 (0.46)
Democratic Catholic	-0.42^{**} (0.15)	-0.004 (0.15)	-0.39 (0.42)
Democratic Secular	0.18 (0.11)	0.19 (0.11)	0.46 (0.31)
Republican Protestant Literalist	-2.94^{***} (0.19)	-1.66^{***} (0.17)	-2.41^{***} (0.32)
Republican Protestant Nonliteralist	-1.70^{***} (0.17)	-1.02^{***} (0.17)	-1.17^{**} (0.38)
Republican Catholic	-0.51^{**} (0.16)	-0.39^{*} (0.17)	-0.93^{**} (0.36)
Republican Secular	-0.23^{*} (0.12)	-0.15 (0.12)	-0.21 (0.31)
Scientific Knowledge	0.17^{***} (0.02)	0.28^{***} (0.02)	-0.05 (0.04)
Education (years)	0.09^{***} (0.01)	0.05^{***} (0.01)	0.08^{**} (0.03)
Household income (real, logged)	-0.02 (0.03)	0.001 (0.03)	-0.03 (0.08)
South	-0.27^{***} (0.06)	-0.09 (0.07)	-0.01 (0.17)
Rural	-0.44^{***} (0.09)	-0.36^{***} (0.10)	-0.07 (0.20)
Observations	5,837	5,482	1,087
Log Likelihood	-2,967.02	-2,828.59	-496.98
Akaike Inf. Crit.	5,994.04	5,717.19	1,043.96

Source: General Social Survey, 2006-2018 (n = 5,850); GSS weight variable: "wtssall"
*Notes: Unstandardized regression coefficients (standard errors in parentheses). Other controls include age, age squared, birth cohort (generation), gender, race/ethnicity, year (as dummies). GSS data for each model come from different years, see Table A3 in Supplementary Materials. Coefficient for "Other" religio-political group not displayed. Statistical significance (two-tailed): *p<0.05; **p<0.01; ***p<0.001*

Figure 2: Partisan Differences in Average Marginal Effects by Religious Group and Outcome



Source: General Social Survey, 2006-2018 (n = 5,850); GSS weight variable: "wtssall"
Note: AMEs are based on the binary logistic regression models in Table 3; 95% confidence intervals displayed

Discussion

In recent years, many researchers have been raising concerns about the politicization of science in the U.S. (e.g., Gauchat 2012, 2015; Mann and Schleifer 2020; McCright and Dunlap 2011). However, many of the studies in this literature at least implicitly assume that the predictive effects of religious and political identities on science beliefs are fixed across the population. That is, they do not use modeling strategies (e.g., use of interaction terms) that allow the link between religious identity and science beliefs to vary by party affiliation. This paper contributes to the literature by proposing and testing a new conceptual framework that generates predictions about what to expect among partisan subsets of major religious groups.

As demonstrated through two empirical studies, this new approach advances our understanding of significant forms of intra-group heterogeneity in key areas of research. First, existing studies, which have assessed the predictive effects of political and religious identities separately, have found that trust in science declined among highly religious people and members of specific religious groups (Gauchat 2012; Evans 2013; Lee 2021). For example, Evans (2013) found that trust in science only declined among Protestants with literal interpretations of the bible who regularly attend churches in conservative denominations. However, as displayed in Figure 1, Study 1 shows that trust in science significantly declined among all three Republican religious groups, but there are no such trends among their religious Democratic counterparts. Thus, contrary to popular narratives, the evidence does not suggest that trust in science declined among certain religious groups more broadly since the 1980s (even conservative Protestants)—but rather, only among specific (Republican) subsets of these groups.

Second, many studies have shown that members of conservative religious groups are more likely to reject specific scientific findings that are contested by their leaders and institutions (Alumkal 2017; Drummond and Fischhoff 2017; Evans 2018; Jelen and Lockett 2014). However, Study 2 shows even after accounting for education, scientific literacy, and other covariates, there are significant intra-group differences within religious groups—which are missed by studies that operationalize these groups as monolithic entities. For example, while both Democratic and Republican Protestant literalists are less likely to accept human evolution and the Big Bang than secular independents, the predictive effects of biblical literalism are substantially greater among Republicans. On other issues politicized by religious elites, like public funding of HESCR, Protestant literalist Democrats are actually similar to secular independents, whereas Protestant literalist Republicans are substantially less likely to support it (by 51 percentage points). This finding extends existing studies that imply the opposition among theologically conservative Protestants to public funding of HESCR is more uniform (e.g., Drummond and Fischhoff 2017; Jelen and Lockett 2014).

This paper also has certain limitations that should be considered. While the religio-political framework (Table 1) was correct more generally in anticipating some significant differences within religious groups in science beliefs, its more specific (and subjectively inferred) predictions were sometimes not supported by the results. For example, in Study 2, the framework predicted that Catholics and Protestant nonliteralists would be similar to secular independents on human evolution or the Big Bang. However, with one exception (Catholic Democrats on the Big Bang), this prediction was not supported. Protestant nonliteralists in both parties were less likely to accept human evolution and the Big Bang; similarly, both groups of

Catholics were less likely to accept human evolution. The framework's inability to correctly predict these outcomes is itself informative and may motivate future research: for example, prominent studies in the literature have argued that Catholic and moderate/liberal Protestant leaders generally do not reject human evolution and the Big Bang (Evans 2013, 2018). While this may be true, the fact that many Catholics and moderate/liberal Protestants in the mass public still do reject these scientific findings suggests a need to revisit the assumed links between elite messaging and public opinion formation.

In addition, due to data limitations, there is no strong basis for inferring causality. While the focus of Studies 1 and 2 was on predicting within-group differences, future research could use experimental designs to assess the mechanisms underlying the significant intra-group heterogeneity documented in this paper (e.g., Chong and Druckman 2007). For instance, survey experiments could be used to measure the causal effects of simultaneously priming the respondents' religious and political identities on the probability of accepting a contested scientific finding.

Nonetheless, the results contribute to our understanding of the nature of mass polarization in beliefs about science (Gauchat 2012; Lee 2021). Today, more than 60% of U.S. adults self-identify as Catholics or Protestants (Pew Research Center 2019), and many of them will encounter messages about science-related issues from their religious leaders. This study is one of the first to show that even among theologically conservative Protestants who favor literal interpretations of the Bible, there are large party divides in science beliefs. Compared to their Republican counterparts, religious Democrats are generally much more similar to secular independents. These findings contribute to an emerging literature, which applies an intersectional approach to the study of science beliefs in the U.S. (Noy and O'Brien 2018). The findings are also related to new research suggesting that opposition to science among certain religious groups may not only be motivated by theology, but also by broader religio-political ideologies like Christian nationalism (Baker et al. 2020; Perry et al. 2021). Given the high costs of distrust in scientific research, these results suggest a need to investigate the conditions under which religious Republicans and Christian nationalists may become more willing to accept scientific findings, even when they are contested by their religious and political leaders.

Supplementary Materials

Appendix A: Sample Summary Statistics for Studies 1 and 2

Appendix A includes Tables A1 and A2, which display the summary statistics for Studies 1 and 2, respectively. As indicated in the main manuscript, the coding for religious group in Studies 1 and 2 was based on three GSS items: religious affiliation ("relig"), bible views ("bible"), and religious attendance variables ("attend"). For those who are less familiar with the GSS religion data, at least three sets of statistics may be surprising. I want to address them in turn.[1]

First, why are the three main religious groups in this study relatively small?

[1] All percentages cited in this section are based on weighted sample proportions (although they do not differ very much from the unweighted sample proportions, see Tables A1 and A2).

Per Tables A1, only about 43.3% of the sample in Study 1 belong to one of the three major religious groups: active Catholic (13.0%), active Protestant literalist (16.4%), active Protestant nonliteralist (13.9%). However, in the sample used in Study 1, 53.0% of respondents self-identify as Protestant and 25.1% self-identify as Catholic—for a total of 78.1% across these two groups.

The main reason for this difference is that as the "active" modifier implies, only those who regularly attend religious services (i.e., at least once per month) are included in these groups. This is due to the nature of the theoretical and historical arguments made in the paper: namely, that certain religious groups are expected to have partisan divides in science beliefs due to the politicization of science by religious and political leaders. In general, those who regularly attend religious services are more likely to encounter such elite messaging than those who do not regularly attend. In addition, religion is likely a more salient social identity for those who regularly attend religious services, relative to those who do not. For both reasons, it is important to distinguish between those who regularly attend religious services and those who do not.

As such, although 78.1% of respondents in the Study 1 sample self-identify as Catholic or Protestant, only 43.3% regularly attend religious services. This paper is more interested in the latter. The remaining Catholics and Protestants were classified in the "Other" or "Secular" group: more on that next.

<u>Second, why is the "Secular" religious group relatively large?</u>

There is an ongoing debate in the literature regarding how secularism should be defined and measured (e.g., Baker and Smith 2015; Niose 2012). While some cases are obvious (e.g., coding religiously unaffiliated people as secular), other cases are less clear (e.g., less observant or non-practicing members of religious groups). For the historical and theoretical reasons described above, the secular group in this study includes both those who are religiously unaffiliated as well as those who are relatively inactive members of their faith groups.

In particular, note that in the Study 1 sample, 44.3% of respondents are coded as being secular: however, only 14.9% of respondents are religiously unaffiliated; the balance is comprised of those who do not regularly attend religious services (i.e., several times a year or less often) and also do not hold literalist beliefs of the bible.

Third, why is the "Other" religious group relatively large?

In the Study 1 sample, 12.4% of respondents are coded as belonging to the "Other" religious group. It is important to note that this group is heterogeneous, including those who belong to other religious groups (e.g., Buddhism, Hinduism, Islam) as well as Catholics/Protestants who do not fit into one of the main three religious groups and the secular group: e.g., those who do not attend religious services regularly but still hold literalist views of the bible. This heterogenous "Other" group is not of theoretical interest to this paper, but was included to ensure that the models accounted for the full joint distribution of covariate values (e.g., see Evans 2013, 373).

Table A1: Sample Summary Statistics for Study 1

Variables	**N**	**Mean (UW)**	**Mean (W)**	**SD**	**Min**	**Max**

High Confidence in Scientists	19,761	41.0%	41.3%			
Age	19,761	46.3	45.0	17.1	18	90
Generation (birth years)	19,761					
Hard Timers (1890-1908)		0.7%	0.6%			
Good Warriors (1909-1928)		9.0%	7.7%			
Lucky Few (1929-1945)		16.2%	15.9%			
Baby Boomers (1946-1964)		39.3%	38.7%			
Gen. X (1965-1982)		26.2%	27.3%			
New Boomers (1983-2001)		8.6%	9.8%			
Male	19,761	44.7%	46.2%			
Race/Ethnicity	19,761					
Black		14.7%	13.9%			
White		77.8%	77.8%			
Other		7.5%	8.3%			
Education (years)	19,761	13.4	13.3	3.0	0	20
HH Income (real, logged)	19,761	9.9	10.1	1.1	5.4	12.0
Religious Group	19,761					
Active Catholic		12.3%	13.0%			
Active Protestant Literalist		16.5%	16.4%			
Active Protestant Nonliteralist		14.0%	13.9%			
Secular		44.6%	44.3%			
Other		12.6%	12.4%			
Party	19,761					
Democrat		48.6%	47.3%			
Republican		35.7%	36.9%			
Independent		15.7%	15.9%			
Religio-Political Group	19,761					
Dem. Protestant Literalist		7.5%	7.0%			
Dem. Protestant Nonliteralist		6.3%	6.0%			
Dem. Catholic		6.1%	6.3%			
Dem. Secular		22.5%	22.0%			
Rep. Protestant Literalist		7.1%	7.5%			
Rep. Protestant Nonliteralist		6.2%	6.3%			
Rep. Catholic		4.6%	4.9%			
Rep. Secular		13.8%	14%			
Secular Independent		8.3%	8.3%			
Other		17.7%	17.7			
South	19,761	36.4%	36.2%			
Rural	19,761	16.0%	15.7%			
High Confidence in Medicine	19,761	41.2%	41.9%			

Source: General Social Survey, 1984-2018 (n = 19,761); GSS weight variable: "wtssall"
Notes: Unweighted (UW) and weighted (W) means and proportions are displayed.

Table A2: Sample Summary Statistics for Study 2

Variables	**N**	**Mean (UW)**	**Mean (W)**	**SD**	**Min**	**Max**
Accept Human Evolution	5,837	47.6%	48.1%			
Accept Big Bang	5,482	36.8%	37.0%			
Support Gov. Funding for HESCR	1,087	73.8%	73.6%			
Age	5,850	47.2	45.7	17.0	18	90
Generation (birth years)	5,850					
Good Warriors (1909-1928)		3.0%	2.1%			
Lucky Few (1929-1945)		12.7%	11.0%			
Baby Boomers (1946-1964)		35.3%	35.4%			
Gen. X (1965-1982)		33.1%	33.2%			
New Boomers (1983-2001)		15.9%	18.4%			
Male	5,850	43.4%	44.7%			
Race/Ethnicity	5,850					
Black		14.8%	13.2%			
White		75.6%	76.3%			
Other		9.7%	10.5%			
Scientific Knowledge Index	5,850	6.0	6.0	2.0	0	9
Education (years)	5,850	13.7	13.7	2.9	0	20
HH Income (real, logged)	5,850	10.0	10.1	1.1	5.4	12.0
Religious Group	5,850					
Active Catholic		10.6%	11.5%			
Active Protestant Literalist		16.5%	16.4%			
Active Protestant Nonliteralist		12.3%	11.5%			
Secular		47.6%	48.3%			
Other		12.9%	12.3%			
Party	5,850					
Democrat		47.5%	45.9%			
Republican		34.0%	35.6%			
Independent		18.5%	18.4%			
Religio-Political Group	5,850					
Dem. Protestant Literalist		6.8%	6.0%			
Dem. Protestant Nonliteralist		5.7%	5.2%			
Dem. Catholic		5.0%	5.3%			
Dem. Secular		23.8%	23.6%			
Rep. Protestant Literalist		7.8%	8.5%			
Rep. Protestant Nonliteralist		5.0%	4.9%			
Rep. Catholic		3.9%	4.4%			
Rep. Secular		13.4%	14.0%			
Secular Independent		10.5%	10.7%			
Other		18.2%	17.4%			
South	5,850	37.9%	38.0%			
Rural	5,850	15.4%	14.4%			

Source: General Social Survey, 2006-2018 (n = 5,850); GSS weight variable: “wtssall”
Notes: Unweighted (UW) and weighted (W) means and proportions are displayed

Appendix B: Additional Methodological Details for Study 2

Table A3 below provides more information about the GSS items used to operationalize each of the three outcomes in Study 2. Next, additional information is provided on the nine GSS items used to construct the scientific knowledge index, which was used as a control in all three models.

Table A3: Description of Science Belief Outcomes in Study 2

Outcome	**GSS item**	**Question text**	**Years**[2]
Human evolution	evolved	*"Human beings, as we know them today, developed from earlier species of animals. (Is that true or false?)"*	2006-2018
Big Bang	bigbang	*"The universe began with a huge explosion. (Is that true or false?)"*	2006-2018
Stem Cell Research	scresrch	*"Recently, there has been controversy over whether the government should provide any funds at all for scientific research that uses 'stem cells' taken from human embryos. Would you say the government…"*	2006, 2010

The scientific knowledge index is an additive measure based on how many of the following questions the respondent answered correctly. The correct answer is in parentheses. Questions 2-9 are based on a question series which is introduced using the following preface: *"Now, I would like to ask you a few short questions like those you might see on a television game show. For*

[2] Even if the data are available in earlier surveys, only data from surveys starting in 2006 were included because that is when the scientific literacy items became available—and scientific literacy is used as a control in all the models.

each statement that I read, please tell me if it is true or false. If you don't know or aren't sure, just tell me so, and we will skip to the next question. Remember true, false, or don't know."

1. *"Now, please think about this situation. Two scientists want to know if a certain drug is effective against high blood pressure. The first scientist wants to give the drug to one thousand people with high blood pressure and see how many of them experience lower blood pressure levels. The second scientist wants to give the drug to five hundred people with high blood pressure, and not give the drug to another five hundred people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug?"* (second scientist is correct)
2. *"The center of the Earth is very hot."* (True)
3. *"All radioactivity is man-made."* (False)
4. *"It is the father's gene that decides whether the baby is a boy or a girl."* (True)
5. *"Lasers work by focusing sound waves."* (False)
6. *"Electrons are smaller than atoms."* (True)
7. *"Antibiotics kill viruses as well as bacteria."* (False)
8. *"The continents on which we live have been moving their locations for millions of years and will continue to move in the future."* (True)
9. *"Does the Earth go around the Sun, or does the Sun go around the Earth?"* (Earth around Sun)

Appendix C: Unweighted Analyses as Robustness Checks

The regression analyses in the main manuscript used the recommended GSS sampling weights ("wtssall"). As a robustness check, the analyses in Studies 1 and 2 were replicated without sampling weights. In general, the core results are substantively similar. Table A4 and Figure A1 display the results of the regression analyses and AMEs for Study 1, respectively. Table A5 and Figure A2 display the results of the regression analyses and AMEs for Study 2, respectively.

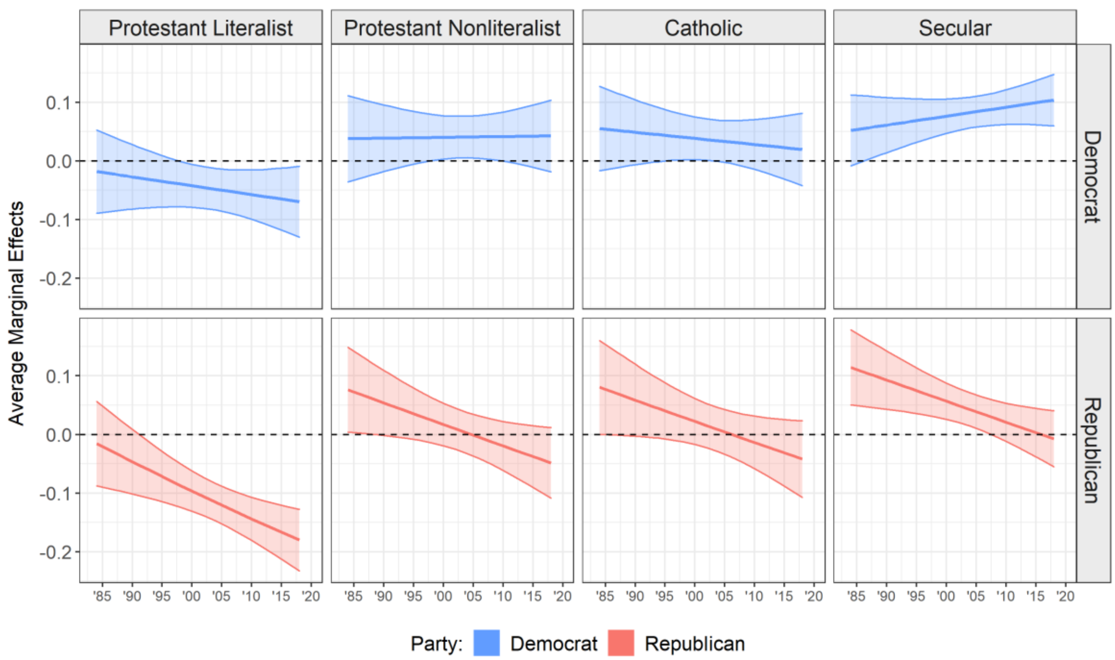
Table A4: Binary Logistic Regressions Predicting Trust in Scientists (Unweighted)

	Outcome: High Confidence in Scientific Community
Religio-Political Group (ref. Secular Indep.)	
Democratic Protestant Literalist	14.72 (16.60)
Democratic Protestant Nonliteralist	-0.84 (16.60)
Democratic Catholic	10.35 (16.54)
Democratic Secular	-13.52 (13.16)
Republican Protestant Literalist	51.89** (16.76)
Republican Protestant Nonliteralist	35.67* (16.57)
Republican Catholic	34.88 (18.21)
Republican Secular	34.52* (14.02)
Year	0.003 (0.01)
Group-year interactions	
Dem. Protestant Literalist * year	-0.01 (0.01)
Dem. Protestant Nonliteralist * year	0.003 (0.01)
Dem. Catholic * year	-0.004 (0.01)
Dem. Secular * year	0.01 (0.01)
Rep. Protestant Literalist * year	-0.02** (0.01)
Rep. Protestant Nonliteralist * year	-0.01 (0.01)
Rep. Catholic * year	-0.02* (0.01)
Rep. Secular * year	-0.01* (0.01)
Education (years)	0.11*** (0.01)
Household income (real, logged)	0.07*** (0.02)
South	-0.04 (0.03)

Rural	-0.13** (0.05)
High Confidence in Medicine	1.32*** (0.03)
Observations	19,761
Log Likelihood	-11,689.70
Akaike Inf. Crit.	23,449.40

Source: General Social Survey, 1984-2018 (n = 19,761)
*Notes: Unstandardized regression coefficients (standard errors in parentheses). Other controls include age, age squared, birth cohort (generation), gender, race/ethnicity. Coefficient for "Other" religio-political group not displayed. Statistical significance: *p<0.05; **p<0.01; ***p<0.001*

Figure A1: AMEs of Religio-Political Group on Trust in Scientists (Unweighted)



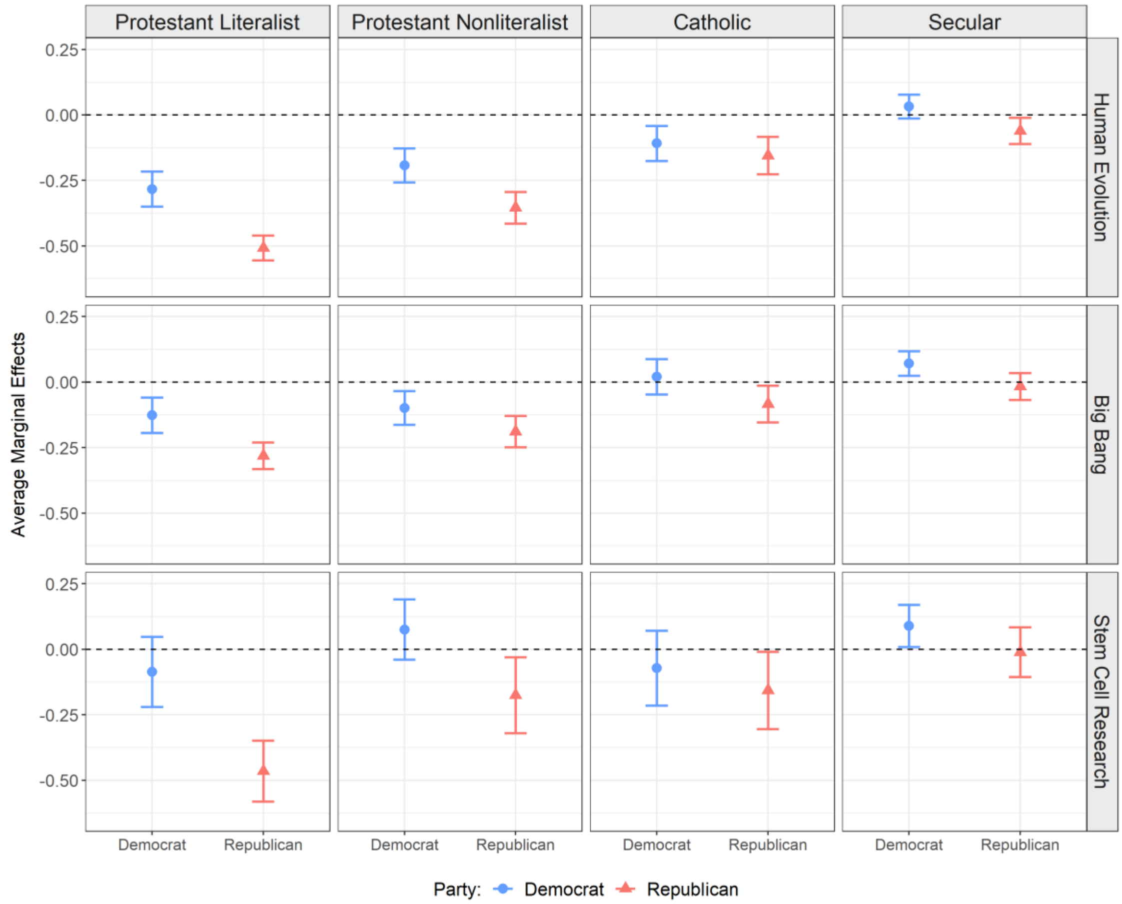
Source: General Social Survey, 1984-2018 (n = 19,761)
Note: AMEs are based on the binary logistic regression models in Table A4; 95% confidence intervals displayed

Table A5: Binary Logistic Regressions Predicting Science Beliefs (Unweighted)

	Dependent variable:		
	(1) Evolution	(2) Big Bang	(3) Funding HESRC
Religio-Political Group (ref. Secular Indep.)			
Democratic Protestant Literalist	-1.28*** (0.16)	-0.62*** (0.18)	-0.48 (0.37)
Democratic Protestant Nonliteralist	-0.86*** (0.15)	-0.48** (0.16)	0.56 (0.47)
Democratic Catholic	-0.48** (0.15)	0.10 (0.16)	-0.40 (0.39)
Democratic Secular	0.15 (0.11)	0.32** (0.11)	0.69* (0.30)
Republican Protestant Literalist	-2.81*** (0.19)	-1.66*** (0.18)	-2.13*** (0.31)
Republican Protestant Nonliteralist	-1.65*** (0.16)	-0.98*** (0.17)	-0.89* (0.36)
Republican Catholic	-0.69*** (0.16)	-0.40* (0.17)	-0.81* (0.37)
Republican Secular	-0.27* (0.12)	-0.08 (0.12)	-0.07 (0.30)
Scientific Knowledge	0.16*** (0.02)	0.28*** (0.02)	0.01 (0.04)
Education (years)	0.10*** (0.01)	0.04*** (0.01)	0.08** (0.03)
Household income (real, logged)	-0.04 (0.03)	-0.04 (0.03)	-0.04 (0.08)
South	-0.25*** (0.06)	-0.13* (0.07)	-0.09 (0.16)
Rural	-0.37*** (0.09)	-0.33*** (0.09)	-0.04 (0.19)
Observations	5,837	5,482	1,087
Log Likelihood	-3,391.29	-3,128.62	-551.18
Akaike Inf. Crit.	6,842.58	6,317.25	1,152.36

Source: General Social Survey, 2006-2018 (n = 5,850)
Notes: Unstandardized regression coefficients (standard errors in parentheses). Other controls include age, age squared, birth cohort (generation), gender, race/ethnicity, year (as dummies). GSS data for each model come from different years, see Table A3. Coefficient for "Other" religio-political group not displayed. Statistical significance: $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

Figure A2: AMEs of Religio-Political Group on Science Beliefs (Unweighted)



Source: General Social Survey, 2006-2018 (n = 5,850)
Note: AMEs are based on the binary logistic regression models in Table A5; 95% confidence intervals displayed

Chapter 3: Measuring Cross-National Variations in Religiosity and Science Attitudes Using Machine Learning

Abstract:

How do mass publics around the world relate to religion and science? In this study, the author uses resampling methods and machine learning to measure how religio-scientific groups are distributed across regions, countries/territories, and religious groups. Across 72 societies (N = 131,804), the results show that 33.0% are traditionalists (pro-religion), 28.8% are modernists (pro-science), 28.6% are post-secularists (pro-both), and 10.6% are postmodernists (pro-neither). Although most societies are dominated by a single class, there is evidence of significant heterogeneity within societies in class prevalence. In addition, the ability of modernization theories to predict variations in class prevalence varies by level of analysis (i.e., individual-level versus macro-level).

Keywords: religion, science, modernization, secularization, machine learning

Introduction

How mass publics relate to religion and science has important implications for sociological theories of development, modernization, and secularization (e.g., Casanova 2011; Eisenstadt 2002; Gorski and Altınordu 2008; Possamai 2017). The conflict thesis, which is the oldest perspective in the literature on this subject, assumes that there is at least some sort of epistemological and/or moral conflict between religion and science. For example, over a hundred and fifty years ago, Auguste Comte argued that every branch of knowledge marches through three successive theoretical conditions: the theological, metaphysical, and positive (Lenzer 1998). In the view of Auguste Comte, Max Weber, and other classical theorists, empiricism and rationality (or science) would eventually replace religion as the primary legitimizing force in society. The conflict thesis is still influential today and has provided the theoretical foundation for many empirical studies in sociology, particularly in the U.S. context (e.g. Alumkal, 2017; Baker et al. 2020; Evans 2013; Gauchat 2012; Scheitle et al. 2018; Sherkat 2011, 2017).

However, in recent years, some sociologists of religion and science have urged colleagues to consider and rigorously test alternative perspectives, such as those suggesting that the relationship between religion and science can be either complementary or independent of each other (Evans and Evans 2008). This has led to the growth of both quantitative and qualitative studies demonstrating that the relationship between religion and science is far from being always or necessarily conflictual (e.g., Ecklund 2020; Evans 2018; DiMaggio et al. 2018; O’Brien and Noy 2015; Vaidyanathan et al. 2016). A key innovation has been the work of O’Brien and Noy (2015), who used latent class analysis to show that significant numbers of U.S.

adults have favorable orientations toward both religion and science (i.e., a "post-secular" group). Yet how common are post-secularists in other parts of the world? In this paper, I extend this work by using resampling methods and machine learning to measure the distribution of religio-scientific groups across regions, countries/territories, and religious groups. Religio-scientific groups are defined as those with distinct views toward religion and science (O'Brien and Noy 2015). In addition, I also assess the extent to which various modernization theories explain cross-national (and micro-level) variations in class membership. While there is a growing body of comparative work in this literature, there are no studies that have measured or predicted variations in latent religio-scientific classes across societies (e.g., Chan 2018; Evans 2014; McPhetres et al. 2020, O'Brien and Noy 2018; Price and Peterson 2016).

In the balance of this paper, I first review the relevant existing literature, with a focus on the available cross-national studies. Next, I draw on several different theories of modernization to review different expectations about the distribution of religio-scientific perspectives across countries/territories. I also discuss the implications of these theories on what we may expect regarding the link between individual-level proxies of economic security (i.e., education, income) and class membership. Finally, I provide an overview of my proposed class estimation procedure, and then discuss the study results and implications.

Existing Literature

Recently, researchers have examined the link between religiosity and science attitudes from a comparative, cross-national perspective (e.g., Chan 2018; Evans 2014; McPhetres et al. 2020; O'Brien and Noy 2018; Price and Peterson 2016). This work is important because the religious landscape significantly varies across countries, and different religious traditions have different sacred texts, which have implications for how followers see science (Christiano et al. 2008). Moreover, objective country conditions vary in terms of economic development, public health, and scientific output; these factors could shape how people see science more generally (as well as in relation to religion). In general, the studies in this literature find that both religiosity (e.g., frequency of prayer) and membership in religious groups (e.g., Protestants, Muslims) are associated with less favorable attitudes toward science and its effects on society. For example, Evans (2014) found that religious people in different traditions (e.g., Catholic, Protestant) in Germany, Norway, Spain, the U.K., and U.S. are significantly less likely to believe that science can provide meaning. Using data from the World Values Survey (2010-2014), Price and Peterson (2016) similarly show that religious people across many different countries are less optimistic about science's effects on society.

More recent studies have focused on identifying important sources of heterogeneity in the link between religiosity, membership in religious organizations, and science attitudes. In one of the most comprehensive studies to date, Chan (2018) examined the extent to which religiosity predicts attitudes toward five different science outcomes in 52 countries: confidence in science, trust in the authority of science, faith in science's ability to provide meaning, the moral effects of science, and interest in science. The author finds that overall (i.e., averaged across all countries), individual-level religiosity is a negative predictor of all five attitudinal outcomes. However, there are two important sources of variation: country context and outcome type. In western countries (e.g., Australia, Sweden, U.S.), religiosity is consistently a negative predictor of all five outcomes; however, for non-western countries (e.g., Algeria, Brazil, South Africa), religiosity is sometimes actually a positive predictor of outcomes including faith in science's ability to provide meaning, the moral effects of science, and interest in science.

While these results are certainly insightful, there is an important limitation in the literature. The vast majority of the relevant studies use regression-type approaches (alone) to estimate the relationship between religiosity, religious group membership, and science attitudes. These types of approaches are typically used to measure the average effect of X on Y (net of controls) across countries or among individuals within countries. For example, some of these studies use hierarchical linear models (HLMs) with random slopes, which allow the estimated net effects of religiosity on science attitudes to vary by country (e.g., Chan 2018; McPhetres et al. 2020). However, these analytical approaches do not explicitly measure or quantify the relative share of each country's population that is in theoretically important religio-scientific cultural groups.

In particular, the sociological literature identifies four theoretically important groups: traditionalists, who are pro-religion; modernists, who are pro-science; post-secularists, who are both pro-religion and pro-science; and postmodernists who are neither pro-religion nor pro-science (O'Brien and Noy 2015). I argue that social scientific theories also make predictions about the relative distribution of people across these theoretically important cultural groups. For example, classical modernization theory would suggest that as economic development increases, there will be more modernists and fewer traditionalists (Chaves 1994; Gorski and Altınordu 2008); on the other hand, according to insights from the postmodernist literature (and risk society theory), economic development is expected to be associated with more postmodernists and fewer post-secularists (Lash 1990; Mirchandani 2005). To use regression analyses to test these predictions, we first need to know the relative proportion of a society's population that is in each of these groups.

Towards this end, I propose a new analytic approach, based on the use of resampling techniques and unsupervised machine learning, to measure the heterogeneity both across and within countries in religiosity and science orientations. A somewhat similar method (i.e., latent class analysis) has been used in two U.S.-based studies. That is, these two studies have attempted to inductively assess the number, relative size, and composition of religio-scientific perspectives in the U.S. context (DiMaggio et al. 2018; O'Brien and Noy 2015). Both ultimately reach a similar conclusion: while many Americans either favor science *or* religion, there is a sizable cluster of people in the U.S. who have favorable attitudes toward both social institutions. Together, these findings are significant because they show that even when attitudes toward religion and science are on average negatively associated with each other (like in the U.S.), there might be a non-trivial number of people in a distinct group where the negative association does not apply (e.g., 30%).

However, existing studies have not used such methods to examine whether similar forms of heterogeneity in religiosity and science attitudes manifest across societies in very different regions of the world.

Theories: Cross-National and Individual-Level Variations in Class Prevalence

In this section, I review three theoretical perspectives that may help predict cross-national variations in class prevalence: classical modernization theory (CMT), multiple modernities theory (MMT), and postmodernism. The last two theories are reviewed more briefly, as they are in many ways modified forms of CMT. I also want to clarify what I mean by modernization, as the literature has conceptualized and operationalized the term in various ways. In its most basic form, modernization is related to the growth of technological advances and other innovations that have increased economic security in a society. However, some more complex or inclusive conceptions of modernization require both the growth of economic security and political rights (Arjomand 1992); others focus more on social changes, such as the growth of individualism, tolerance, and social progressiveness (e.g., Inglehart 2018). In this paper, I use the most basic conceptualization of modernization because the more complex and inclusive alternatives are arguably related to other concepts (e.g., political rights are associated with democracies). Moreover, the central theorized mechanism in all three perspectives (CMT, MMT, RST) is the growth of economic security, not political rights or social norms per se.

(Classical) Modernization Theory

In its classical form, modernization theory suggests that as countries "modernize" (i.e., as evidenced by economic development), religiosity will decline and trust in science will increase. According to Max Weber, one of the key distinguishing features of a modern society is its focus on rationalization: compared to their pre-modern counterparts, modern societies favor reason, evidence, and logic over traditions and religious texts. In such contexts, urbanization, industrialization, and the growth of technology have meant that the division of labor tends to be more complex and differentiated. As such, many jobs require specialized training and expertise

(Shapin 1996). Scientists spend years undergoing extensive training and finishing formal education to acquire specialized knowledge in their respective domains (e.g., chemistry, statistics). Accordingly, in many wealthy countries with high levels of scientific research and technological innovation, key public institutions are increasingly more likely to justify their decisions using reason, logic, and scientific evidence (Drori et al. 2003; Smith 2003). Moreover, people are more likely to be interested in scientific topics; possess greater scientific knowledge; and have more trust in scientists, scientific research, and scientific institutions (Krause et al. 2019; Noy and O'Brien 2019).

A close corollary of modernization theory is the secularization thesis. According to this view, as societies modernize, the influence of religion in both the public and private spheres will decline (Chaves 1994; Gorski and Altınordu 2008; Voas and Chaves 2016). In pre-modern societies, religion is dominant over the phenomena that cannot yet be explained (i.e., those that are perceived to be supernatural or spiritual). However, over time, science progressively expands the size of its domain (or boundaries of its cultural authority) as many things previously considered "supernatural" become more explicable: e.g., thunderstorms, droughts, natural disasters (Bruce 2011; Inglehart 2018). This process occurs gradually, due to a growth in the widespread accessibility of public education and the rise of new scientific and technological advancements (e.g., astronomy, engineering). As religion increasingly loses its prestige in the eyes of the mass public, religious texts, doctrines, and traditions are less likely to be used to justify public policies and social norms. Moreover, as these increasingly scientific societies modernize, people are more likely to adopt socially liberal norms, which tend to be associated with the decline of religiosity in the private sphere as well. In sum, proxies of modernization (i.e., higher levels of economic development) are assumed to predict more favorable attitudes toward science (classical modernization theory) and less religiosity (secularization theory).

> Hypothesis 1 (Classical Modernization Theory): (a) Societies with higher levels of economic development are expected to have fewer traditionalists and more modernists; (b) within societies, those with more economic security (income, higher education) will be less likely to be traditionalists and more likely to be modernists.

Multiple Modernities Perspective

A central criticism of modernization theory is that it is based on the trajectories followed by mostly western European societies, the U.S., Canada, Australia, and New Zealand. Many scholars argue that such Western-centric narratives fail to account for the social, cultural, and political differences in other regions of the world (e.g., in South Asia, Middle East) that have also been experiencing economic development. While the literature on the multiple modernities perspective is large (e.g., Casanova 2011; Eisenstadt 2002; Possamai 2017; Spohn 2010), the most relevant theoretical argument in this context is that economic development and the growth of scientific innovation can occur without a serious decline in religiosity. In other words, this perspective suggests that increasingly developed and scientific (i.e., modern) societies can be highly religious as well.

Hypothesis 2 (Multiple Modernities): (a) Societies with higher levels of economic development are expected to have more post-secularists (highly religious people with favorable attitudes toward science); (b) within societies, those with more economic security (income, higher education) are more likely to be post-secularists.

Postmodernism and Risk Society Theory

Another alternative to classical modernization theory is postmodernism, a movement that arose during the 20th century in response to modernism (Lash 1990). While modernists favor reason and empiricism (science) over religion or tradition, postmodernists are highly skeptical of universal truth claims more generally—arguing that they are socially constructed and context dependent (Mirchandani 2005). Postmodernists are also suspicious of grand narratives (e.g., the idea of ongoing scientific or human progress) and institutionalized authority. Because postmodernism is a reaction to modernism, a related implication is that there will be more postmodernists in wealthier societies (everything else being equal).

There are other reasons to expect the mass publics in highly developed economies to have less favorable science orientations. According to risk society theory, while people in technologically advanced societies are more likely to be familiar with the benefits afforded by modern science (e.g., new inventions), they are also more aware of the potential harms and new risks posed by scientific research (Beck 1992; Price and Peterson 2016). For instance, the negative consequences of technology include widespread pollution and the invention of increasingly destructive military weapons (e.g., combat drones, chemical warfare). In addition, people in more developed economies are also more likely to be familiar with highly publicized controversies associated with scientists and scientific institutions. Examples include the inconsistencies within the sciences, as exemplified by the replication crisis (Baker 2016; Shrout and Rodgers 2018); and instances of fraudulent research practices in both the natural and social sciences (Carey 2015; Thompson and Clark 2018). In addition, certain political and religious groups in western societies like the U.S. have publicly accused scientists of being biased and pursuing their own ideological agendas (Mann and Schleifer 2020). This may explain why public attitudes toward the scientific community have become polarized in certain contexts (Lee 2021).

> Hypothesis 3 (Postmodernism): (a) Societies with higher levels of economic development are expected to have fewer post-secularists and more postmodernists; (b) within societies, those with more economic security (income, higher education) are more likely to be postmodernists and less likely to be post-secularists.

Data and Methods

Data

The individual-level data in this study come from the World Values Survey (WVS), a well-known international survey program that regularly carries out nationally representative surveys in societies around the world (Inglehart et al. 2020). In particular, the analytic dataset included 131,804 respondents: 68,732 respondents from 56 countries/territories in Wave 6 (2010-2016);

and 63,072 respondents from 49 countries/territories in Wave 7 (2017-2020).[3] The WVS is an ideal data source for the study because the same demographic, social, and economic survey items were asked in a wide variety of societies: e.g., those in East Asia, Latin America, Middle East and North Africa (MENA), Sub-Saharan Africa, Western Europe, among others. First, I examine the relevant religion and science items and how they were operationalized.

The literature shows that science orientations are multifaceted, encompassing a number of different dimensions: e.g., interest in science, scientific knowledge, and trust in science (Johnson et al. 2015). To measure science orientations, I created an additive index by combining four items that appear together in the same question series. Respondents are asked to indicate how strongly they agree or disagree with the following statements (1 = strongly disagree, 10 = strongly agree): (1) "Science and technology are making our lives healthier, easier, and more comfortable"; (2) "Because of science and technology, there will be more opportunities for the next generation"; (3) "It is not important for me to know about science in my daily life"; (4) "One of the bad effects of science is that it breaks down people's ideas of right and wrong."[4] Items 3 and 4 are reverse coded, so that higher scores indicate more positive attitudes toward science. These science items are designed to measure the extent to which people think positively about the effects of science (items 1-2), interest in science (item 3), and the moral implications of

[3] The final analytic sample only included cases that were not missing data on the variables used in the study.
[4] This question series includes an additional item; however, it was not included because it asks respondents to consider religion in relation to science: "We depend too much on science and not enough on faith." The goal of the science index is to measure people's orientations toward science itself.

science (item 4). The index is constructed by adding each respondent's score across the four items, with a higher overall score indicating a more favorable science orientation.[5]

To measure religiosity, respondent answers to the following three items were used. The first question asks respondents to rate the importance of religion to their lives and the responses are coded from 1 ("Not at all important") to 4 ("Very important"). The second question asks about the frequency of attendance at religious events (e.g., services) and the answer choices are coded from 1 ("Never, practically never") to 7 ("More than once a week"). Similarly, the third question asks about the frequency of prayer and the answers are coded from 1 ("Never, practically never") to 8 ("Several times a day"). While other religiosity items are available (e.g., subjective importance of God), only these three items are used because they are generally applicable across all major religious groups: e.g., Buddhism, Hinduism, Islam, Protestant Christianity, and Roman Catholicism.

Estimating Class Membership

The first step in the analytical strategy is to estimate each respondent's membership in a latent (or unobserved) religio-scientific group using data from the WVS. Recall that four theoretically important groups have been identified in the sociological literature: traditionalists, modernists, post-secularists, and postmodernists. Table 1 shows that these groups (or classes) can be identified based on their placement with respect to two dimensions: religiosity and science

[5] It is not appropriate to create the science index by using a method like principal component analysis (PCA), because only the first two science items are highly correlated with each other. Correlations with items 3 and 4 are lower, because they represent distinct (but important) dimensions of science orientations.

orientations (or attitudes). Traditionalists tend to be more religious and have less favorable science orientations, whereas modernists are less religious and have more favorable science orientations (Bruce 2011; Chaves 1994; Inglehart 2018). Post-secularists are both religious and have favorable science orientations (Casanova 2011; Eisenstadt 2002); whereas postmodernists are both less religious and have less favorable science orientations (Lash 1990; Mirchandani 2005).

Table 1: Religio-Scientific Groups

	Unfavorable Science Orientation	Favorable Science Orientation
High Religiosity	Traditionalist	Post-Secularist
Low Religiosity	Postmodernist	Modernist

There are two studies in this literature that have measured the number, size, and composition of religio-scientific groups in the U.S. context using latent class analysis (LCA; DiMaggio et al. 2018; O'Brien and Noy 2015). LCA is a type of mixture model that estimates the probability of class membership by unit (respondent) based on values of observed indicators (Bouveyron et al. 2019). LCA has certain qualities that often make it a good method for conducting exploratory analyses: i.e., it is very fast; requires few assumptions; and produces model fit statistics (e.g., BIC, likelihood ratio tests), which help researchers to identify the optimal number of classes.[6] However, a well-known disadvantage is that LCA often produces parameter estimates (clustering solutions) that are unstable: e.g., every time it is run, the estimated class probabilities for each unit and even the optimal number of classes can vary quite significantly (Nylund-Gibson and Choi 2018). This variability is due to LCA's usage of the expectation maximization (EM) algorithm, which randomly selects the initial parameter values before iteratively adjusting the values to improve model fit. One option is to run the LCA many times (with different initial parameters) to see if the procedure converges on a stable solution; unfortunately, LCA often fails to produce a stable clustering solution even after a large number of trials.[7]

For this reason, and also because the literature has generated strong priors on the "correct" number of classes (i.e., the purpose is no longer exploratory), I used an alternative approach to estimate the probability of class membership in this study. First, I created 263,608 bootstrap samples (each with n = 1,000) by sampling with replacement from the full analytic sample; 263,608 is equal to twice the number of respondents in the full analytic sample.[8] For each subsample, a religiosity index and science orientation index were constructed using the WVS items described previously. After rescaling both indices (mean = 0 and standard deviation = 1), I clustered the respondents in each subsample using agglomerative hierarchical clustering

[6] The main assumption is conditional independence, which means that the covariance among the observed indicators is due to latent class membership (Nylund-Gibson and Choi 2018). Another assumption is that class membership is both mutually exclusive and exhaustive.

[7] Somewhat more technically: in LCA, the EM algorithm continues to re-estimate the parameters until there are no additional improvements to the likelihood function; however, because of random initialization, the solution often converges to a local maxima (instead of the global solution).

[8] Each respondent's probability of selection into a subsample was proportional to their sampling weight, in order to create more representative subsamples. To reduce variance for subsampling purposes, extremely large weights were trimmed: i.e., such that weights exceeding the median + interquartile range (IQR) * 4 are set at that upper threshold (Potter and Zheng 2015).

(AHC). AHC is a popular unsupervised machine learning algorithm: each unit starts off as its own cluster; the distances between each pair of units are computed (i.e., a distance matrix); in each successive stage, the two most similar clusters are merged to form a single larger cluster (Reynolds et al. 2006).[9] For each subsample, the AHC solution corresponding to four clusters is selected.

To identify the most optimal four cluster solution for each subsample, the algorithm uses Ward's method of minimizing within-cluster variances. The similarity (or dissimilarity) among each pair of cases is measured using the Euclidean distance. In this study, the Euclidean distance for any given pair of respondents is displayed below. In the equation, r refers to the standardized religiosity index; s refers to the standardized science attitudes index; the subscripts denote the respondent number; and d represents the Euclidean distance between (r_1, s_1) and (r_2, s_2).[10]

$$d = \sqrt{(r_2 - r_1)^2 + (s_2 - s_1)^2}$$

Recall that AHC was run on each of the 263,608 bootstrap samples. This means that on average, each respondent appeared in 2,000 subsamples—and was thus clustered an average of 2,000 times, although the actual number varied across respondents.[11] At the end of this process, four

[9] One of the main reasons for selecting AHC is that it uses a deterministic algorithm that produces stable results: i.e., for any given subsample and the same number of clusters, class assignments are always the same. Thus, the only source of variation in the class assignment for a given respondent is the composition of its particular subsample, which by definition is a function of a random selection process.

[10] One assumption underlying the use of the Euclidean distance is that each dimension is equally important; that assumption is satisfied here because in this context, there is no reason to assign a larger weight to the religiosity index relative to the science attitudes index, and vice versa.

[11] Since AHC was run on each of the 263,608 bootstrap samples, and each subsample included 1,000 respondents, that means that there were a total of 263,608,000 classifications: or on average, 2,000 per

outcomes are estimated for each respondent: the probability of membership in each of the four classes. To compute each respondent's probability of membership in a class (e.g., post-secularist), we simply take the number of times they were assigned to that specific class and divide that by the total number of times the respondent was classified. For a more detailed overview of the class estimation procedure, see Appendix A.

This class estimation strategy has several notable strengths, which are related. First, it offers a good fit for the theory: note that membership in a religio-scientific class is inherently relative. Whether someone is particularly religious depends on whom they are compared against; someone who may be highly religious in one society is quite ordinary in another. Thus, respondents should be (repeatedly) compared to the global joint distribution of feature values. Second, the approach offers a better way of reducing measurement error. Hard assignment makes more sense when class membership is clearly categorical (and mutually exclusive). However, what should be done for respondents who are somewhat near the dividing line between two or three classes (e.g., modernists and post-secularists)? That uncertainty (or heterogeneity) should be explicitly quantified. Since the probability of class membership is estimated many times for each respondent, the estimations are more reliable (lower variance).[12] Third, the method also quantifies the degree (or intensity) of class membership, providing more information for researchers: there are important qualitative differences between someone who is merely more likely than not to be in class X (e.g., probability of 51%) and someone who is almost certainly in that class (e.g., probability of 98%).

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each of the 131,804 respondents in the analytic sample. Those with higher sampling weights appeared in more subsamples and were thus classified more times.

[12] This is similar to the logic underpinning the use of ensemble methods in other machine learning techniques, such as random forests (Hastie et al., 2017).

Analytical Methods

Next, I estimate four separate hierarchical linear models to assess the individual-level and contextual predictors of variations in class membership. In particular, I fit separate two-level hierarchical linear models (HLM) for each outcome (Raudenbush and Bryk 2002): individuals (level 1) are nested within country/territory clusters (level 2); the random intercepts allow the intercepts to vary across level 2 units. At the individual-level, there are two main predictors: family income, measured using a 1-10 point scale (deciles); and university graduate (yes = 1, no = 0). Family income and holding a four-year degree are assumed to be proxies of economic security and exposure to science. Income is group-mean centered in the HLM analyses. I also control for each individual's gender; age group (18-30, 31-45, 46-60, 61 and older); and religious affiliation (Buddhist, Eastern Orthodox, Hindu, Jewish, Muslim, Other Christian, Other, Protestant, Roman Catholic, Unaffiliated). The reference groups are woman, 18-30, and Unaffiliated, respectively.

At level 2, the main predictor is the percentile rank of GDP per capita, which is adjusted for purchasing power parity (PPP) since the costs of living vary significantly across countries. GDP per capita is considered by many economists and other social scientists to be a measure of a country's level of overall wealth; it is frequently used by scholars to operationalize a country's degree of modernization (e.g., Inglehart 2018). The GDP data for each country were provided by the World Bank and are grand-mean centered (Raudenbush and Bryk 2002). At level 2, I control for a society's level of political rights and civil liberties, based on Freedom House scores (free, partly free/not free). The reference category is partly free/not free (a combined category). Regime type measures are available from Polity V, but only for sovereign states, so the Freedom House ratings were used instead as they are available even for territories.

All regression analyses use sampling weights that adjust for sampling designs within societies (where available) and unequal sample sizes across societies (Appendix B). Tables 2 and 3 display the summary statistics for the individual-level and country/territory-level variables, respectively.

Table 2: Summary Statistics for the Individual-Level Variables

Variables	**N**	**UW Mean**	**W Mean**	**SD**	**Min**	**Max**
Cluster Inputs: Religiosity						
Importance of Religion	131,804	3.1	3.1	1.1	1	4
Religious Attendance	131,804	4.0	4.0	2.2	1	7
Frequency of Prayer	131,804	5.4	5.4	2.7	1	8
Cluster Inputs: Science Attitudes						
ST Creates More Opportunities	131,804	7.7	7.7	2.3	1	10
ST Improves Lives	131,804	7.5	7.6	2.4	1	10
Important to Know about Science	131,804	6.4	6.4	2.9	1	10
Science Does Not Harm Morality	131,804	5.6	5.6	2.8	1	10
Class Membership	131,804					
Traditionalist		33.2%	32.0%			
Modernist		28.6%	28.8%			
Post-Secularist		27.8%	28.6%			
Postmodernist		10.4%	10.6%			
University Graduate	131,804	21.2%	19.9%			
Income Scale	131,804	4.9	4.8	2.1	1	10
Religious Group	131,804					
Buddhist		5.3%	5.0%			
Eastern Orthodox		9.8%	11.9%			
Hindu		2.4%	1.9%			
Jewish		0.2%	0.2%			
Muslim		27.2%	28.1%			
Protestant		8.9%	8.5%			
Roman Catholic		19.5%	19.9%			

Other Christian		3.7%	3.4%			
Other		2.9%	2.7%			
Unaffiliated		20.1%	18.4%			
Age Group	131,804					
18 to 30		30.9%	32%			
31 to 45		30.5%	30.3%			
46 to 60		23.7%	22.9%			
61 and older		14.9%	14.8%			
Male	131,804	48.4%	49.0%			

Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 131,804 individuals
Notes: Unweighted (UW) and weighted (W) means/proportions are displayed, respectively. To illustrate the original distributions of the quantitative variables, none of them have been standardized or rescaled.

Table 3: Summary Statistics for the Country/Territory-Level Variables

Variables	**N**	**Mean or %**	**SD**	**Min**	**Max**
GDP per Capita (PPP, constant dollars)	68	18,750	15,421	1,490	82,065
Civil Liberties and Political Rights	68				
Free		39.7%			
Partly Free or Not Free		60.3%			

Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 68 countries/territories
Notes: To illustrate the original distribution of GDP per capita (PPP), it was not rescaled

Results

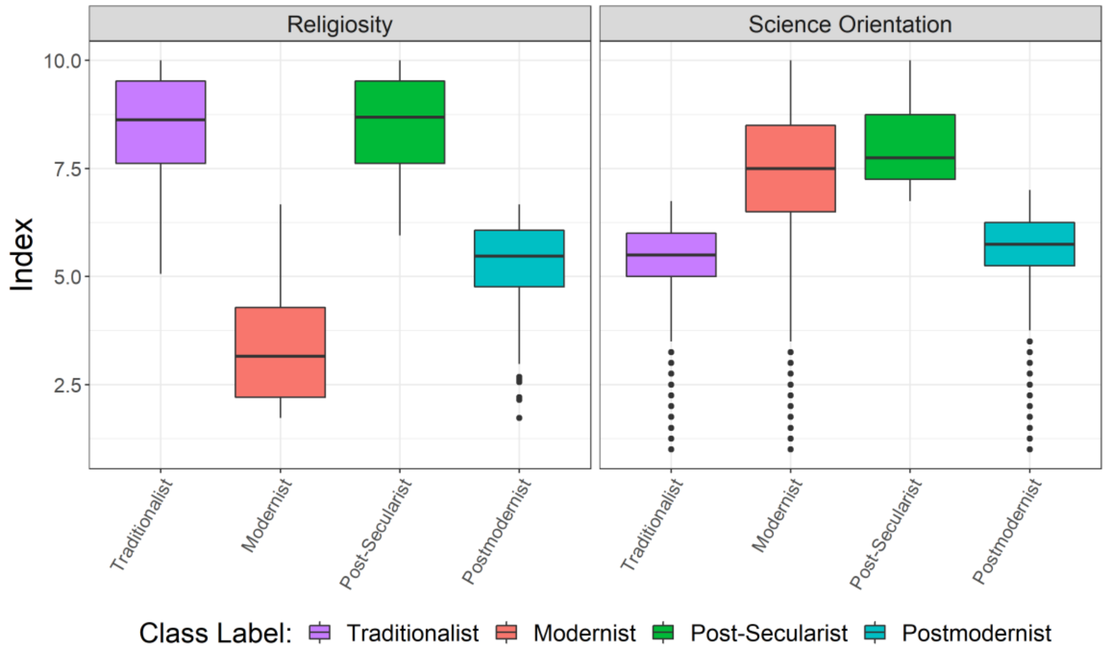
Diagnostics

Recall that the probability of membership in each of the four classes is computed for every respondent (continuous variables). Each respondent's predicted class (a categorical variable) is simply the class with the highest predicted probability. As displayed in Table 2, across the full analytic sample, the distribution of class membership is as follows: 33.0% are traditionalists (pro-religion); 28.8% are modernists (pro-science); 28.6% are post-secularists (pro-both); and 10.6% are postmodernists (pro-neither).[13] Before examining the class distributions across regions, countries/territories, and religious groups, I first briefly review some diagnostics based on the class estimation results.

There are different ways to assess the quality of the class assignment procedure. In the context of this paper, I examine class separation, construct validity, and reliability (e.g., see Hastie et al. 2017). Figure 1 displays boxplots comparing the interquartile ranges (i.e., the 25th to 75th percentiles) of the religiosity and science orientation indices across the four classes. For comparability, both indices were scaled to be from 1-10 (see Appendix C for more details). Note that there is evidence of significant class separation in the expected directions: traditionalists and post-secularists are significantly more religious on average than modernists and postmodernists; on the other hand, modernists and post-secularists have significantly more favorable science orientations than traditionalists and postmodernists.

Figure 1: Boxplots Displaying Distributions of Religiosity and Science Orientation by Class

[13] Weighted proportions are used here, although the unweighted proportions are substantively identical.



Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 131,804

Class separation tells us whether classes (operationalized as a categorical variable) are significantly distinct on average in the expected ways (Hastie et al. 2017). Next, we examine whether the *probability* of class membership (a continuous variable) is correlated with the degree of religiosity and favorable science orientations; this has implications for construct validity, since there should be meaningful differences between someone who is only marginally more likely to be in a class (e.g., 51%) versus someone who is almost certainly in that class (e.g., 98%). In short, the Pearson correlation coefficient (PCC) between the probability of membership in each class and each dimension is either moderately high or strong (and in the expected directions). For example, the probability of traditionalist class membership has PCCs of 0.57 and -0.66 with religiosity and science orientation, respectively; and the probability of postmodernist class membership has PCCs of -0.53 and -0.35 with religiosity and science orientation, respectively (see more details, see Table A3, Appendix C).

To assess reliability in this context, we can examine the percentage of respondents with a dominant class. An individual has a "dominant" class if the probability that they belong to any specific class exceeds 50%; this means that given many simulations (2,000 on average) in which they were repeatedly compared to different random subsamples of respondents across 72 diverse societies, they were assigned to the same class more than half of the time. The greater the probability of belonging to any specific class, the more confident we are that they truly belong to the class. Using this definition, about 91% of individuals have a dominant class; moreover, on average, respondents were classified in their highest probability (most likely) class about 77% of the time. To put that into perspective, if class membership did not matter (or were truly random), then the probability of membership in each class across respondents would be 25%. These results provide additional support for the reliability (or consistency) of the estimation procedure used. For additional diagnostics on the class estimation results, see Appendix C.

Descriptive Results

Next, we can aggregate the respondents' most likely classes at the country/territory level, to estimate the largest class for each country/territory. Table 4 below displays the four main classes and the list of societies in which each class (e.g., traditionalist) is the largest. There are several key findings. First, in most societies, there is a single dominant class that makes up over half of the adult population. Across all 72 societies in the sample, the largest class in a society on average constitutes 54% of its population; in 21 societies, the largest class exceeds 60% of the population (a supermajority). Second, there appears to be some regional patterns in class dominance. For example, in 26 societies, disproportionately from Latin America, traditionalists are the largest class. In 26 societies, disproportionately from East Asia and the West, modernists are the largest class. However, while there are some general regional trends, there are also notable forms of heterogeneity as well. For example, while traditionalists are particularly common in Latin America, they are also the largest class in parts of Southeast Asia (Philippines, Thailand); Europe (Cyprus, Romania); and the MENA region (Jordan, Lebanon, Turkey). Moreover, while post-secularists are particularly dominant in Muslim-majority countries, post-secularists also constitute the largest class in parts of Central/Eastern Europe (Armenia, Georgia, Poland); and Sub-Saharan Africa (Rwanda, Zimbabwe). For a list of societies by region, see Table A2, Appendix D.

Table 4: Largest Classes Across 72 Countries and Territories

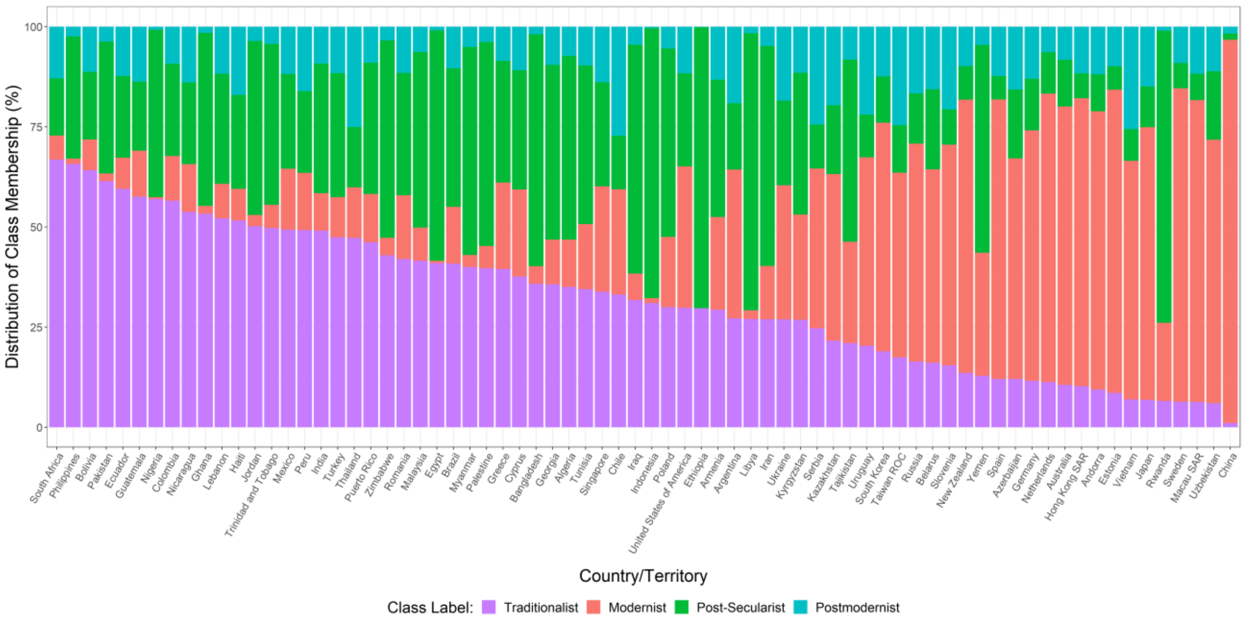
Class Label (Largest Class)	**N**	**Avg.**	**Societies where the Class is the Largest**
Traditionalist	26	50.6%	Bolivia, Brazil, Chile, Colombia, Cyprus, Ecuador, Ghana, Greece, Guatemala, Haiti, India, Jordan, Lebanon, Mexico, Nicaragua, Nigeria, Pakistan, Peru, Philippines, Puerto Rico, Romania, Singapore, South Africa, Thailand, Trinidad and Tobago, Turkey
Modernist	26	59.7%	Andorra, Argentina, Australia, Azerbaijan, Belarus, China, Estonia, Germany, Hong Kong SAR, Japan, Kazakhstan, Macau SAR, Netherlands, New Zealand, Russia, Serbia, Slovenia, South Korea, Spain, Sweden, Taiwan ROC, Ukraine, United States of America, Uruguay, Uzbekistan, Vietnam
Post-Secularist	20	52.3%	Algeria, Armenia, Bangladesh, Egypt, Ethiopia, Georgia, Indonesia, Iran, Iraq, Kyrgyzstan, Libya, Malaysia, Myanmar, Palestine, Poland, Rwanda, Tajikistan, Tunisia, Yemen, Zimbabwe

Postmodernist	0	N/A	None

Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 131,804
Notes: Third column displays the average percentage across societies in each group (row) where the class is the largest; proportions are weighted.

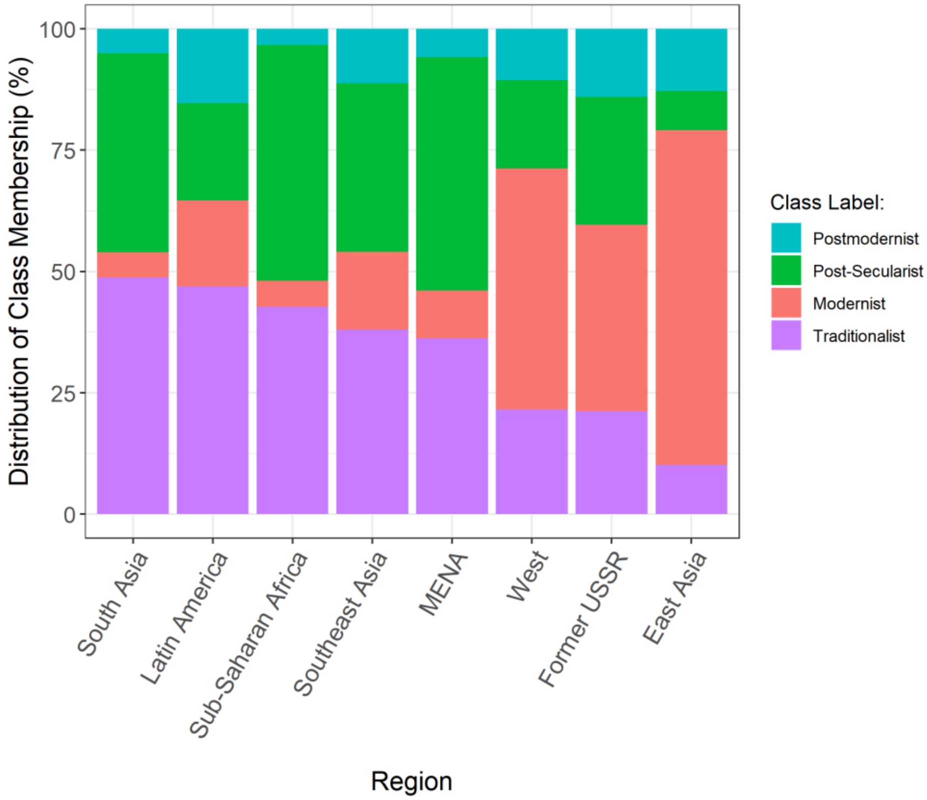
Third, while many societies have a single dominant class, there is also evidence of significant "market" fragmentation as well. Figures 2 and 3 display the distribution of class membership across countries/territories and regions, which are arranged in descending order with respect to the relative size of the traditionalist class. In both figures, we can see that there is significant evidence of heterogeneity in class membership *within* these areas. Whereas large numbers of traditionalists and modernists generally do not co-exist in the same area (which is consistent with classical modernization theories), it is common to find large numbers of traditionalists and post-secularists together; notable examples include societies in Africa, the MENA region, South Asia, and Southeast Asia. On the other hand, postmodernists are often a significant minority in contexts with large numbers of modernists (e.g., societies in East Asia and the West).

Figure 2: Class Distribution Across 72 Countries/Territories



Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 131,804
Notes: Weighted proportions displayed

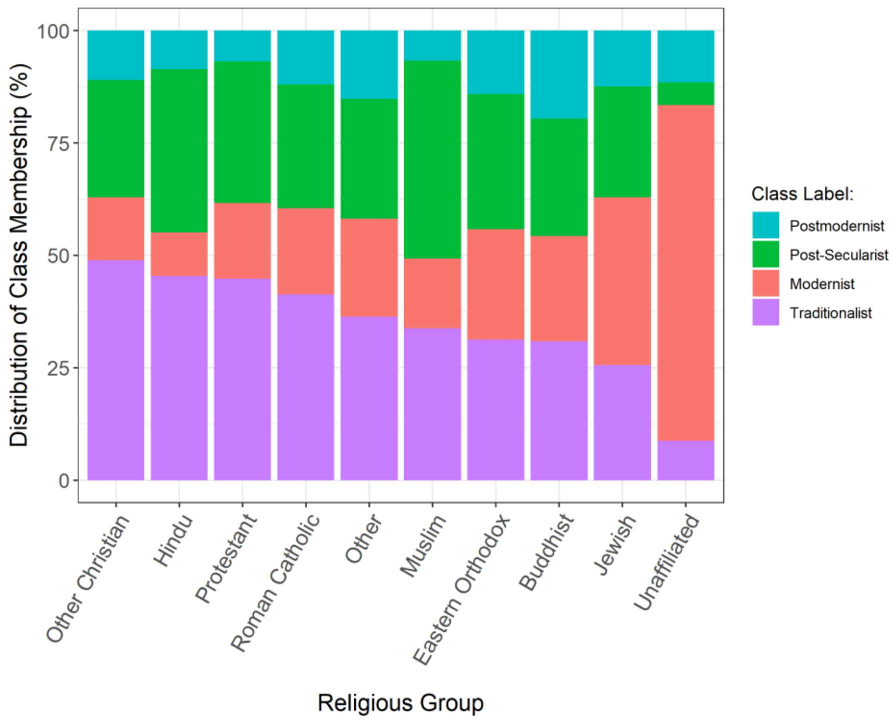
Figure 3: Distribution of Class Membership by Region



Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 130,086
Notes: Weighted proportions displayed

Is there a conflict between religion and science? Figure 4 displays the class distributions across major religious traditions. There is little evidence that religious people are categorically (or even mostly) anti-science. Perhaps unsurprisingly, traditionalists constitute the largest religio-scientific group across most religious traditions: e.g., they make up 45% of Hindus, 45% of Protestants, and 41% of Roman Catholics. However, across the religious traditions, there are also significant numbers of post-secularists and modernists, who have positive or favorable science orientations. In fact, post-secularists are the largest class among Muslims (44%), while modernists are the largest class among Jewish people (37%).

Figure 4: Distribution of Class Membership by Religious Group



Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 131,804
Notes: Weighted proportions displayed

Multilevel Regression Analyses

How well do key modernization theories explain individual-level and macro-level variations in class membership? To address this question, we turn to the results of the HLM analyses, which are displayed in Table 5. There are four continuous outcomes: the probability of membership in each of the four classes (Models 1-4). Hypothesis 1a (Classical Modernization Theory) predicts that societies with higher levels of economic development will have fewer traditionalists and more modernists. The results support the latter half of this prediction (i.e., regarding modernists). According to Model 1 (Table 5), a society's degree of wealth is not significantly associated with cross-national differences in the prevalence of the traditionalist class.[14] However, Model 2 shows that society wealth is both a statistically and substantively significant predictor of larger modernist classes across countries/territories. For example, an increase in the society's percentile rank of GDP per capita (PPP) by 20 points (e.g., from the 50^{th} to 70^{th} percentile) is associated with a 5-percentage point increase in the relative share of modernists in that society. At the individual-level within societies, Hypothesis 1b predicts that those with more economic security (income, higher education) are less likely to be traditionalists and more likely to be modernists. The results support this prediction, although the predictive effects for income are substantively small. Net of covariates, an increase of 2-3 deciles in income (relative to the society mean) is associated with less than a one percentage point change in the probability of membership in the traditionalist and modernist classes. The predictive effects are larger for higher education: having a university degree is associated with a 5.4 percentage point decrease in the probability of being a traditionalist, and a 2.6 percentage point increase in the probability of being a modernist (Models 1 and 2, Table 5).

Table 5: HLM Results Predicting the Probability of Class Membership as a Function of Economic Development/Security and Controls

[14] As a reminder, society wealth is operationalized as the percentile rank of GDP per capita (PPP, grand-mean centered).

	Dependent variable: Probability of Class Membership			
	Traditionalist	Modernist	Post-Secularist	Postmodernist
	(1)	(2)	(3)	(4)
Individual-level				
Male	-3.26^{***}	2.89^{***}	0.45^{*}	-0.07
	(0.19)	(0.13)	(0.19)	(0.09)
Age Group: 31 to 45	3.41^{***}	-3.07^{***}	0.54^{*}	-0.88^{***}
	(0.24)	(0.17)	(0.23)	(0.12)
Age Group: 46 to 60	4.55^{***}	-4.69^{***}	1.68^{***}	-1.54^{***}
	(0.27)	(0.19)	(0.26)	(0.13)
Age Group: 61 and older	8.70^{***}	-8.14^{***}	2.13^{***}	-2.70^{***}
	(0.32)	(0.22)	(0.31)	(0.15)
Income	-0.17^{***}	0.23^{***}	0.07	-0.13^{***}
	(0.05)	(0.03)	(0.05)	(0.02)
University Degree	-5.35^{***}	2.60^{***}	4.58^{***}	-1.84^{***}
	(0.26)	(0.18)	(0.25)	(0.12)
FE for Religious Group	yes	Yes	yes	yes
FE for Year	yes	Yes	yes	yes
Country/Territory-level				
Country Wealth	-0.13	0.24^{***}	-0.21^{**}	0.09^{**}
	(0.07)	(0.07)	(0.07)	(0.03)
Free Society	-0.72	3.22	-4.45	1.94
	(4.26)	(4.10)	(4.07)	(1.85)
Observations	124,936	124,936	124,936	124,936
Countries/Territories	68	68	68	68
Log Likelihood	-627,059.70	-581,689.60	-623,809.60	-535,988.20
Bayesian Inf. Crit.	1,254,460.00	1,163,720.00	1,247,959.00	1,072,317.00

Sources: World Values Survey, Waves 6 and 7; World Bank; Freedom House
Notes: Standard errors in parentheses. Estimation accounts for sampling weights. Reference category for age group is 18-30. Statistical significance (two-tailed): $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

Hypothesis 2a (Multiple Modernities) predicts that societies with higher levels of economic development will have more post-secularists (highly religious people with favorable attitudes toward science). The results do not support this prediction, as country wealth is a statistically significant predictor of smaller post-secularist classes across countries/territories. An increase in a society's percentile rank of GDP per capita (PPP) by 20 points is associated with a 4 percentage point reduction in the society's share of post-secularists (Model 3, Table 5). Hypothesis 2b predicts that within societies, those with more economic security (income, higher education) are more likely to be post-secularists. Here, the results are mixed: while income is not a significant predictor of post-secularist class prevalence within societies, higher education is. Individuals with a university degree are 4.6 percentage points more likely on average to be post-secularists, who are religious but also have favorable science orientations.

According to Hypothesis 3a (Postmodernism), societies with higher levels of economic development are expected to have fewer post-secularists and more postmodernists. The results support both of these macro-level predictions: as previously discussed, society wealth is a significant predictor of smaller post-secularist classes across countries/territories. In contrast, a society's level of wealth is a statistically significant predictor of larger postmodernist classes, although the predictive effects are not substantively large: a 20 point increase in the society's percentile rank of GDP per capita (PPP) is associated with a 2 percentage point increase in the society's relative share of postmodernists. Finally, Hypothesis 3b predicts that within societies, those with more economic security are more likely to be postmodernists and less likely to be post-secularists. This prediction is not supported by the results, with both higher income and having a university degree being statistically significant predictors of a lower probability of being a postmodernist (see Model 4; though the predictive effects are not substantively large in size); and with highly educated people being more likely to be post-secularists (Model 3).

Discussion

How do mass publics in different regions of the world relate to science and religion? The primary substantive contribution of this paper is the quantification of how religio-scientific classes are distributed across regions, countries/territories, and religious groups. This is an important contribution to the sociological literature at the nexus of religion and science for several reasons (Alumkal 2017; Chan 2018; Ecklund and Scheitle 2017; Evans 2013; Gauchat 2012; Scheitle et al. 2018). First, it extends the innovative work of O'Brien and Noy (2015) and DiMaggio et al. (2018), who showed that large numbers of U.S. adults have favorable orientations toward both religion and science ("post-secularists"). These findings have been interpreted as offering evidence against the popular epistemological conflict thesis, which argues that religion and science offer incompatible cultural schemas for understanding the world (e.g., for a review see Evans and Evans 2008; Evans 2018). The present study extends this work by demonstrating that there are significant numbers of post-secularists in most regions of the world. In a diverse sample of 72 societies (N = 131,804), post-secularists constitute at least 10% of the adult population in 62 societies; and over 50% or a majority in 11 societies (e.g., Bangladesh, Ethiopia, Myanmar, Rwanda). These results offer support for the generalizability of the compatibility thesis, which suggests that large subsets of mass publics see religion and science as being complimentary and not engaged in conflict (Ecklund 2020; Ecklund and Scheitle 2017; Vaidyanathan et al. 2016).

Second, existing cross-national studies have used regression-type methods to show that religiosity is typically (i.e., on average) associated with less favorable science attitudes across countries and territories (Chan 2018; Evans 2014; Price and Peterson 2016). However, to the best of my knowledge, this study is the first to show that there is a significant degree of heterogeneity in religio-scientific classes even *within* regions, countries/territories, and religious groups. For example, even in societies where traditionalists are the largest class, there are often significant numbers of post-secularists and modernists (e.g., Chile, Singapore). This has implications for our understanding of what kinds of political coalitions may form when science and religion compete with one another for influence and power in the public sphere (Alumkal 2017; Baker et al. 2020; Mooney 2006; Otto 2016). For example, when religious and scientific institutions clash over issues such as the origins of humankind or the morality of certain scientific procedures (Evans, 2018), will traditionalists and post-secularists ally themselves against modernists and post-modernists? Future research can assess these interesting possibilities.

Third, explicitly measuring the distribution of religio-scientific classes at the country/territory level allows us to test modernization theories in new ways (e.g., Casanova 2011; Gorski and Altınordu 2008; Possamai 2017). To what extent does economic development (country-level) and economic security (individual-level) predict variations in class prevalence? The results show that the predictive ability of prominent modernization theories depends on the level of analysis. Classical modernization theory made directionally accurate predictions at both the individual and macro levels regarding the prevalence of modernists (+), while the results for traditionalists were more mixed. The predictions of the multiple modernities perspective were supported at the individual level, but not at the society level: i.e., economic development is associated with fewer post-secularists across countries/territories, but economic security within societies is associated with a higher probability of being a post-secularist. The reverse was true for the predictions based on postmodernism, where the predictions were supported at the society level but generally not at the individual level (regarding post-secularists and postmodernists). These differences may be examples of the ecological fallacy, and further research is necessary to understand the reasons behind this disconnect across levels.

Finally, this study also contributes to the literature by demonstrating the use of a new method for measuring latent socio-cultural groups in the population (c.f., O'Brien and Noy 2015). The approach, based on bootstrap sampling and repeated hierarchical clustering, is relatively easy to understand, is computationally feasible, and has statistically desirable properties (e.g., high class separation). However, the study is also subject to limitations that should be noted. First, the 72 countries and territories included in Waves 6 and 7 of the WVS were not randomly selected from the universe of societies. Thus, there may be some concerns regarding generalizability; however, the sample itself is quite diverse, encompassing societies from virtually every major region of the world. The other limitation is that the HLM coefficients presented represent averages across dozens of societies; thus, they can mask important forms of heterogeneity. Indeed, supplementary analyses shows that the direction and size of the link between individual-level proxies of economic security and class membership vary significantly across regions of the world (Figures A1 and A2, Appendix E). Future research could address potential reasons for this variability, by developing and testing new hypotheses; future studies could also assess whether the clustering solutions are robust to the inclusion of alternative observed indicators of religiosity and/or science orientations.

The sociological literature at the nexus of religion and science, which has strong ties to modernization and secularization theories, is an exciting and continuously growing area of research. It is my hope that this study contributes to ongoing scholarly debates in this area by providing a new lens via which we can understand key sources of heterogeneity in public attitudes toward these two very important social institutions.

Supplementary Materials

Appendix A: Additional Details on the Class Estimation Procedure

Below, I provide more details on each step of the class estimation procedure. The replication R files are also publicly available.

<u>Steps:</u>

1. Create 263,608 bootstrap samples by sampling with replacement from the full analytic sample.
    a. Each subsample has a sample size of 1000.

b. As noted in the main text (weighted sampling): *"Each respondent's probability of selection into a subsample was proportional to its sampling weight, in order to create more representative subsamples."*[15] In practice, this means that respondents with large sampling weights appeared in more subsamples, and were thus classified (clustered) more times.

c. Note that 263,608 equals exactly twice the number of respondents in the full analytic sample. This is by design, as it means that on average, each respondent will be classified (or clustered) on average 2,000 times (more on this later).

2. <u>Repeat steps 3-7 separately for each subsample (i.e., 263,608 times).</u>

3. Prepare the data for clustering by creating a religiosity index and science orientation index.

   a. The science orientation index is an additive index that combines four items: *"These science items are designed to measure the extent to which people think positively about the effects of science (items 1-2), interest in science (item 3), and the moral implications of science (item 4)."*

   b. The religiosity index is based on the first principal component (PC) after using PCA to combine three highly correlated measures: self-evaluation of religiosity, frequency of participation in religious activities/events, frequency of prayer.

4. Standardize both indices (i.e., to have a mean of 0 and a SD of 1) so that they are measured on the same scale.

---

[15] "*To reduce variance for subsampling purposes, extremely large weights were trimmed: i.e., such that weights exceeding the median + interquartile range (IQR) * 4 are set at that upper threshold (Potter and Zheng 2015).*"

5. Perform hierarchical clustering, using Ward's method of minimizing within-cluster variances.
    a. To measure the similarity (or dissimilarity) among each pair of cases, the Euclidean distance is used. This results in the creation of a distance matrix (1,000 by 1,000).
    b. Note that the main manuscript includes an equation representing the Euclidean distance between any two cases within the context of this study (i.e., assuming there are two equally weighted features—religiosity and science attitudes).
6. Cut the dendrogram so that 4 clusters are identified (i.e., the four cluster solution that minimize within-cluster variances).
7. Provide substantive labels to the 4 clusters using the following method:
    a. For each cluster, compute the mean value of the standardized religiosity and science attitudes indices among the respondents assigned to the group
    b. Compare each cluster's means to the following thresholds: for each dimension, if the cluster's mean value is zero or below zero, code as "low"; otherwise, code as "high."
    c. Note that there are four possible substantive labels, which correspond to the four cells in Table 1 (two dimensions by two levels).
8. Recall that steps 3-7 are repeated for each of the 263,608 subsamples and that each subsample contains 1,000 randomly selected cases. Thus, on average, each respondent has been classified 2,000 times.[16]

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[16] However, the actual number of times a respondent was classified varied significantly, since the probability of inclusion in a subsample accounted for (trimmed) sampling weights. In total, it took my

a. Compute each respondent's probability of membership in each of the four classes in Table 1, by using the percentage of the times the respondent was assigned to each class.

Appendix B: Sampling Weights

S017 is the original WVS weight variable provided by the countries that adjust for country-specific sampling designs (where available): i.e., respondents who are underrepresented relative to their true proportion in the population (e.g., based on race/ethnicity, age) receive a weight above 1.0 while those who are overrepresented receive a weight below 1.0 (Medrano n.d.). The magnitude of S017 represents the extent to which the respondent is under or overrepresented.

The final weights used in the main analyses further adjust for differences in sample sizes across countries/territories by dividing each respondent's S017 weight by 1500. These final weights are designed to account for both unequal probabilities of selection within each country and also differences across countries in sample size. Below, w_{ij} refers to the final weight for the ith respondent in country/territory j, and $S017_{ij}$ refers to the value of the original country weight variable for the ith respondent in country/territory j.

laptop about 3.5 hours to finish the procedure (~263.6 million classifications, given ~263.6K subsamples each with n = 1,000). Thus, while the approach is somewhat computationally intensive, it is not prohibitively costly even for medium to somewhat large-sized samples and a standard laptop.

$$w_{ij} = \frac{S017_{ij}}{1500}$$

Note that the sum of w_{ij} within each country/territory always equals 1500. This weight variable is used in all regression analyses (i.e., all HLMs and pooled OLS regressions by region).

Appendix C: Class Estimation Diagnostics – Additional Details

To examine class separation and construct validity, I created new versions of the religiosity and science orientation indices that were measured on a 1-10 point scale.[17] The indices for each respondent in the analytic dataset (n = 131,804) were computed using the formulas below. As a reminder, the three input indices for religiosity include: a self-evaluation of religiosity (coded from 1-4), the frequency of participation in religious activities or events (coded from 1-7); and the frequency of prayer (coded from 1-8). Each item is multiplied by a factor that converts the item to a 1-10 scale; next, these three rescaled items are averaged.

Constructing the 1-10 index for science orientations is simpler, as there are four items and each item is already measured using a 1-10 point scale. The four items are simply added together and then divided by 4. The purpose of this approach is to ensure that both indices are measured on the same 1-10 scale and are thus comparable.

[17] Note that this method of index construction is somewhat different than the methods used to create the religiosity and science orientation indices for the purposes of the clustering. In particular, the latter involved the use of PCA for the science orientation cluster, and standardizing the variables (to have a mean of 0 and a SD of 1). The reason for using a slightly different approach to address some diagnostics is that the results are easier to interpret.

$$relig\_index_i = \frac{\left[relig_i * \left(\frac{10}{4}\right) + activities_i * \left(\frac{10}{7}\right) + prayer_i * \left(\frac{10}{8}\right)\right]}{3}$$

$$sci\_index_i = \frac{sci\_1_i + sci\_2_i + sci\_3_i + sci\_4_i}{4}$$

In the main manuscript, boxplots were displayed, which allowed readers to compare the interquartile ranges (i.e., the 25th to 75th percentiles) of religiosity and science orientation indices across the four classes. Another way of considering class separation is to compare the conditional item means across the four classes. The results are displayed below in Tables A1 (unweighted) and A2 (weighted). We would draw the same conclusions as from the boxplots: namely, that there is evidence of significant class separation. The four classes are quite different on average and in the expected ways.

Table A1: Comparing Conditional Item Means Across the Four Classes (Unweighted)

	Religiosity	Religious Activities	Prayer	Science Item 1	Science Item 2	Science Item 3	Science Item 4
Traditionalist	3.7	5.2	7.1	6.3	6.6	4.7	4.3
Modernist	2.0	1.8	2.2	8.1	8.1	7.2	6.6
Post-Secularist	3.7	5.2	7.2	8.9	8.9	8.0	6.5
Postmodernist	2.7	2.9	4.2	6.4	6.6	5.0	4.6

Table A2: Comparing Conditional Item Means Across the Four Classes (Weighted)

	Religiosity	Religious Activities	Prayer	Science Item 1	Science Item 2	Science Item 3	Science Item 4
Traditionalist	3.7	5.2	7.0	6.3	6.5	4.7	4.2

Modernist	2.0	1.8	2.2	8.1	8.1	7.1	6.6
Post-Secularist	3.7	5.2	7.2	8.9	9.0	8.0	6.5
Postmodernist	2.7	2.8	4.2	6.4	6.6	5.0	4.5

Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 131,804
Notes: These science items are designed to measure the extent to which people think positively about the effects of science (items 1-2), interest in science (item 3), and the moral implications of science (item 4).[18] *Higher numbers indicate more favorable science orientations.*

Next, to assess construct validity, we can examine whether the *probability* of class membership (a continuous variable) is correlated with the degree of religiosity and favorable science orientations. The Pearson correlation coefficients (PCCs) are displayed in Table A3. As noted in the main text, the PCC between the probability of membership in each class and each dimension is either moderately high or strong—and in the expected directions.

Table A3: Correlation Between the Religiosity/Science Orientation Indices and the Probability of Class Membership

	Religiosity Index	Science Orientation Index
Traditionalist	0.57	-0.66
Modernist	-0.92	0.34
Post-Secularist	0.52	0.56
Postmodernist	-0.53	-0.35

Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 131,804

[18] The four science items, in order: (1) “Science and technology are making our lives healthier, easier, and more comfortable”; (2) “Because of science and technology, there will be more opportunities for the next generation”; (3) “It is not important for me to know about science in my daily life”; (4) “One of the bad effects of science is that it breaks down people’s ideas of right and wrong.” Items 3 and 4 are reverse coded, so that higher scores indicate more positive attitudes toward science.

Appendix D: Societies by Region of the World

Table A4: List of Countries and Territories by Region

Region	**List of Countries and Territories**[19]	**Total Number**
East Asia	China, Hong Kong SAR, Japan, Macau SAR, South Korea, Taiwan ROC	6
Former USSR	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Ukraine, Uzbekistan	10
Latin America	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guatemala, Haiti, Mexico, Nicaragua, Peru, Uruguay	12
Middle East and North Africa (MENA)	Algeria, Egypt, Iran, Iraq, Jordan, Lebanon, Libya, Palestine, Tunisia, Turkey, Yemen	11
South Asia	Bangladesh, India, Pakistan	3
Southeast Asia	Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam	7
Sub-Saharan Africa	Ethiopia, Ghana, Nigeria, Rwanda, South Africa, Zimbabwe	6
West	Andorra, Australia, Cyprus, Estonia, Germany, Greece, Netherlands, New Zealand, Poland, Puerto Rico, Romania, Slovenia, Spain, Sweden, United States of America	15
Other (Not Categorized)[20]	Serbia, Trinidad and Tobago	2

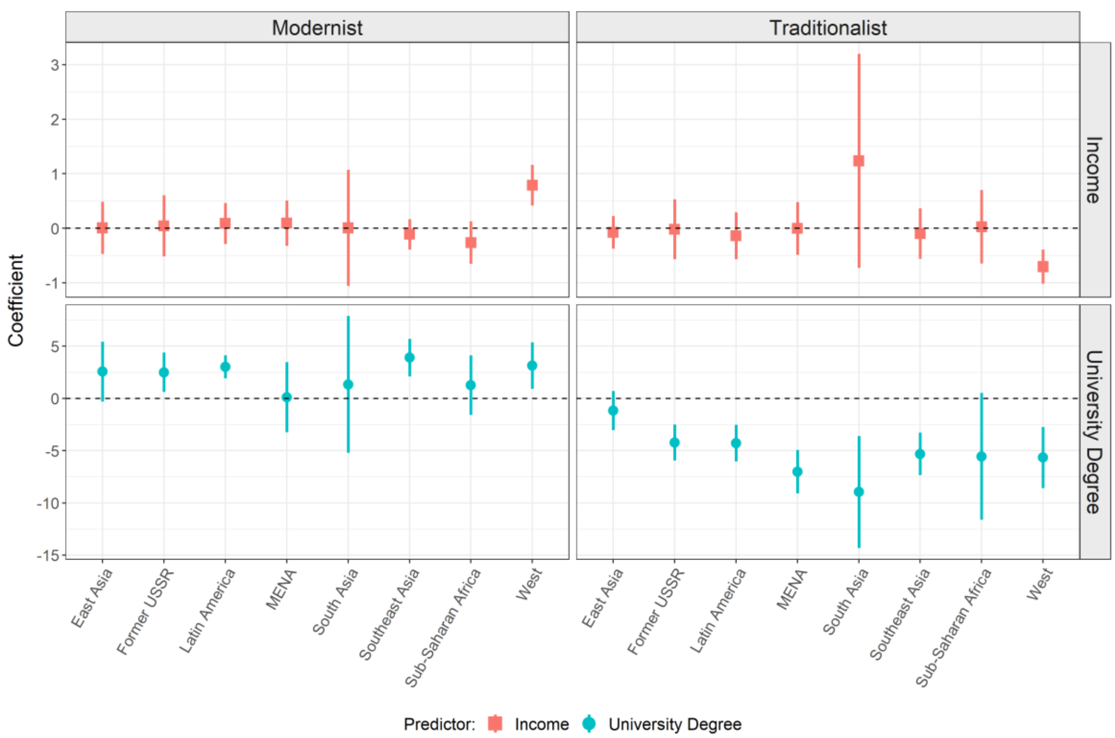
*Notes: *The following societies were not included in the HLM analyses: Andorra, Hong Kong SAR, Macau SAR, Taiwan ROC. The reason is that they are missing data for the required (level 2) covariates.*

Appendix E: Supplementary Analyses

[19] SAR stands for special administrative region; ROC stands for Republic of China.
[20] These two countries did not fit easily into any of the existing eight regions. They were included in the HLM analyses but not in the pooled OLS regressions by region.

Do key individual-level predictors (income, education) vary in direction and size across contexts? I estimated pooled OLS regressions separately by region predicting the probability of membership in each of the four classes as a function of income, university degree (yes/no), gender, age group, and religious affiliation. In these models, dummies are also added for country and period.[21] Robust standard errors are clustered over country-year cells. The coefficients for the two key predictors are displayed in Figures A1 (traditionalist and modernist classes) and A2 (post-secularist and postmodernist classes).

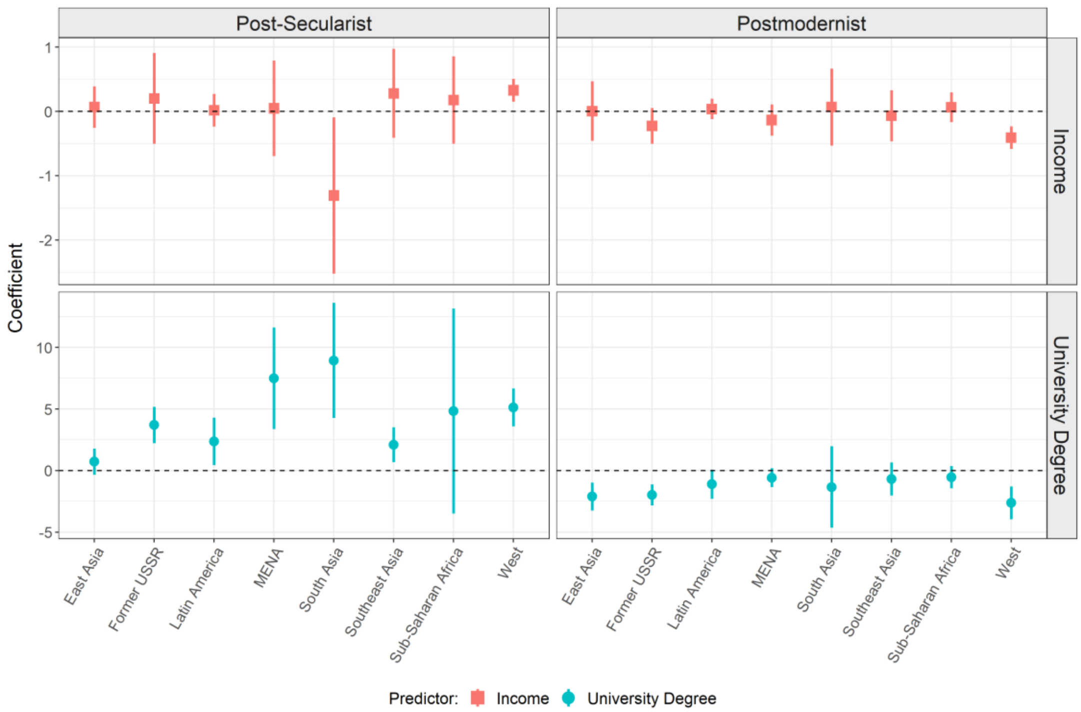
Figure A1: Predictive Effects of Income and Higher Education on the Probability of Modernist and Traditionalist Class Membership by Region



[21] Year fixed effects are not used, because of collinearity with country/territory fixed effects. There are five periods, each covering two years: 2010-2011, 2012-2013, 2014/2016, 2017-2018, 2019-2020. For two regions (Former USSR, Latin America) only, even this period variable caused collinearity issues, so a two-period dummy was used: 2010-2014, 2016-2020.

Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 130,086
Note: Results are from the pooled OLS regressions by region. Sampling weights used.

Figure A2: Predictive Effects of Income and Higher Education on the Probability of Post-Secularist and Postmodernist Class Membership by Region



Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 130,086
Note: Results are from the pooled OLS regressions by region. Sampling weights used.

Chapter 4: Religious Exclusivism (Not Science Optimism) Strongly Predicts Beliefs about the Cultural Authority of Science: A Cross-National Study

Abstract:

When religion and science are in conflict, who supports religion? Using data from 71 diverse societies in the World Values Survey (n = 120,728), this study assesses the relative predictive strength of science optimism, moral concerns about science, religiosity, and religious exclusivism. The results show that science beliefs are weak predictors of the outcome, even in wealthy societies with high levels of scientific productivity. In contrast, religious exclusivism (believing that only one's religion is acceptable) is the strongest predictor of choosing religion over science; this is generally consistent across religious groups, regions, and specific countries/territories.

Keywords: science and technology, religion, comparative sociology, modernization, secularization

Introduction

Conflicts between religious and scientific institutions in the public sphere are central to sociological theories of modernization and secularization (Bruce 2011; Casanova 2011; Eisenstadt 2002). For example, classical modernization theorists such as Max Weber argued that in modern societies, public policies are designed based on evidence and logic ("rationalization"), rather than by traditions or religious teachings. That is, in wealthier and more scientific societies, science should enjoy more cultural authority than religion, while the reverse should be true in less developed economies. Institutions with high cultural authority enjoy social prestige, create knowledge, and confer legitimacy (Inglehart 2018; Shapin 1995). The idea that there is conflict (whether epistemological or moral) between religion and science is still prominent today, motivating research across the social sciences (e.g., Alumkal 2017; Cacciatore et al. 2018; Evans 2013; Gauchat 2012, 2015; Scheitle et al. 2018; Sherkat 2011, 2017).

Drawing on data from 71 diverse societies in the World Values Survey (n = 118,956), the present study addresses two main research questions. First, to what extent do science optimism, moral concerns about science, religiosity, and religious exclusivism predict support for religion when religion and science are in conflict (net of covariates)? This question is motivated by social scientific theories including the cultural ascendancy and alienation theses, among others (Barber 1990; Gauchat 2012). Second, as suggested by modernization theories, how do macro-level conditions (i.e., wealth, scientific productivity) moderate the link between these individual-level predictors and the outcome? In addition to its implications for sociological theory, the study addresses two existing empirical limitations in the relevant cross-national literature, which are briefly discussed next.

Recently, a growing number of studies have examined public attitudes toward religion and science from a comparative, cross-national perspective (Chan 2018; Evans 2014; McPhetres et al. 2020; O'Brien and Noy 2018; Noy and O'Brien 2019; Price and Peterson 2016). Overall, these studies generally find that across countries, religious people hold less favorable beliefs about science or its effects on society (e.g., Evans 2014; Price and Peterson 2016). However, the outcome of interest is often a measure of science optimism, or favorable beliefs about the effects of science on society (c.f., Chan 2018). For example, it is plausible that those who believe science benefits society are more likely to trust scientific evidence and defer to scientific guidelines (Barber 1990; Robbins 2016). However, whether (and to what extent) favorable beliefs about science predict a willingness to trust science—particularly when its authority is contested—is an empirical question that should be investigated, not merely assumed (Evans and Evans 2008; Gieryn 1999; Oreskes 2019).

Second, the key religion predictor in these studies is almost always a measure of religiosity or membership in particular religious groups (e.g., Chan 2018; McPhetres et al. 2020; O'Brien and Noy 2018). However, recent insights from the U.S. suggest that measures of fundamentalism may be a stronger predictor of beliefs about the cultural authority of science than religiosity or even membership in specific traditions (e.g., Protestants or Catholics). For example, studies have shown that biblical literalists have lower levels of scientific literacy (Sherkat 2011); are less likely to trust scientists (Evans 2013; Sherkat 2017); and are more likely to reject specific scientific findings related to human evolution and the Big Bang (Drummond and Fischhoff 2017; Jelen and Lockett 2014). In contrast, members of more moderate or liberal Christian groups are less likely to express disagreements with science (Evans 2018); and other studies using latent class analysis have shown that large groups of religious Americans have favorable attitudes toward science (DiMaggio et al. 2018; O'Brien and Noy 2015). Do these findings generalize to contexts outside of the U.S., such that opposition to the cultural authority of science is more related to conservative religious orientations (e.g., absolutism or exclusivism) rather than religiosity per se?

The Rise of Modernity and Conflicts Between Religion and Science

Modernization: The Triumphs and Perils of Science

The first two hypotheses are related to the stunning achievements of modern science as well as its potential liabilities, respectively: the cultural ascendancy and alienation theses (Gauchat 2012). According to the cultural ascendancy thesis, there are reasons to expect trust in science to increase over time (Barber 1990; Gauchat 2012). Over the past several decades, the global scientific community has made remarkable advances in fields such as microbiology, genetics, agricultural sciences, chemical engineering, robotics, and computer vision (e.g., Bennett 2019; Sachdev 2014). Collectively, these achievements have significantly improved the quality of life for people around the world (e.g., improving public health, longevity, productivity). As new inventions and scientific innovations are widely publicized, mass publics are more likely to be familiar with the contributions of scientists—and the cultural prestige of science is likely to grow accordingly (Gieryn 1999; Oreskes 2019).

While many of these arguments are more clearly applicable to the context of advanced, highly developed economies, I argue that even the populations of low-income countries have reasons to think favorably about modern science. Over the past several decades, the populations of developing economies have also been increasingly benefiting from new developments in science, technology, and medicine. For example, life expectancy at birth, a common measure of human development, has increased dramatically in Sub-Saharan Africa—improving from less than 45 years in 1970 to about 61 years in 2017 (World Bank 2019). Access to information about scientific innovation is also more widely available today than ever before. According to a June 2019 report by the Council on Foreign Relations, there are now 525 million internet users in Africa, compared to about 447 million in Latin America and the Caribbean, and 328 million in North America (Campbell 2019).

On the other hand, the rise of science has also brought a growing awareness of related moral concerns or problems. For example, many political leaders and social groups have expressed concerns about the ethics of scientific procedures involving human cloning, human embryonic stem cell research, and human gene editing (Evans 2013, 2018). They warn that certain scientific innovations create new morally ambiguous spaces, where the lines between "right" and "wrong" are increasingly blurred. Similarly, there is also a growing awareness that technological innovations (e.g., in manufacturing, chemical engineering) generate significant levels of pollution, which are tied to global climate change (Otto 2016). This fear is related to the arguments of "risk society" theorists in sociology, who have drawn a link between modernization, industrialization, and the advent of new "manufactured risks" such as environmental degradation (Beck 1992; Giddens 1999). Sociologists have published numerous studies demonstrating that elites and prominent groups, particularly in the U.S., have used these moral concerns to politicize scientific research and challenge the authority of scientists—often with some degree of success (Alumkal 2017; Baker et al. 2020; Evans 2013; Gauchat 2012, 2015; Lee 2021; Mann and Schleifer 2020; McCright and Dunlap 2011).

As such, the alienation thesis suggests that public confidence in science has declined due to moral concerns about certain scientific innovations (e.g., human gene editing) and new risks posed by modern science (e.g., pollution). While these two theoretical perspectives are primarily about trends in mass beliefs about science (Gauchat 2012), they have implications for how people may respond to explicit conflicts between religion and science. In particular, those with more optimism about the effects of science on society likely have more trust in science as well; as such, they are less likely to defer to religion when religion and science are in conflict (Hypothesis 1). In contrast, those with greater moral concerns about the effects of science may favor institutions that claim expertise over moral, ethical, or philosophical matters; this may lead them to support religion given a conflict between the two institutions (Hypothesis 2). Moreover, these associations are likely to be amplified in wealthier (i.e., "more modern") societies, where people are more likely to have direct experiences with both the triumphs and perils of modern science.

Hypothesis 1 (cultural ascendancy): (a) Optimism about the effects of science on society is associated with less support for religion, when religion and science are in conflict; (b) this predictive effect is stronger in societies with more wealth and higher scientific productivity.

Hypothesis 2 (alienation): (a) Moral concerns about the effects of science on society are associated with more support for religion, when religion and science are in conflict; (b) this predictive effect is stronger in societies with more wealth and higher scientific productivity.

Multiple Modernities and Religiosity

The first two hypotheses are broadly related to sociological theories of development, modernization, and risk: i.e., the social and cultural transformations that follow economic changes (Giddens 1999; McMichael 2016). Whereas classical forms of modernization theory generally require or imply secularization, the multiple modernities paradigm has emerged as an alternative suggesting that economic development (and scientific innovation) is compatible with the continued role of religion in public life (e.g., Casanova 2011; Eisenstadt 2002; Possamai 2017). A common argument among multiple modernity theorists is that classical modernization theories (e.g., a la Weber) focus too much on the experiences of Western societies, at the cost of downplaying countries in regions such as Latin America, the Middle East and North Africa (MENA), and Southeast Asia. In these regions, religion is often still the primary force sustaining and legitimizing social norms, traditions, and even forms of governance (Inglehart 2018). In sum, insights from the multiple modernities literature would suggest that religious identity is a strong predictor of choosing religion over science given a conflict, especially in non-Western societies. In particular, research suggests that two key dimensions of religious identity may be especially relevant: (1) religiosity, an indicator of the relative salience of membership in a particular religious group; (2) and religious exclusivism, a measure of the fundamentalism of one's religious beliefs (i.e., content of religious beliefs).

When religiosity is operationalized such that it only (or mostly) represents subjective self-evaluations of religiosity and self-reported behaviors (i.e., and not the content of religious beliefs or religious group membership per se), the measure in some sense represents the relative salience of religious group membership (Burke and Stets 2009; Christiano et al. 2008). The higher this religiosity measure, the more intensely the individual perceives the importance of membership in their particular religious group. Thus, I expect that those who more closely identify with their religious group would, even net of the content of their religious beliefs, be more likely to side with religion when religion and science are in conflict. Intuitively, these kinds of individuals tend to experience the most psychological discomfort when their group is "wrong" and thus feel the most need to show support for "their team" (Abrams and Hogg 1990).

> Hypothesis 3 (multiple modernities): (a) Religiosity (net of religious exclusivism) is associated with more support for religion, when religion and science are in conflict; (b) this predictive effect is stronger in non-Western societies.

The Primacy of Religious Exclusivism (Fundamentalism)

The second key dimension of religious identity is what the individual actually believes (i.e., the content of their religious belief). Sociologists and social psychologists have long been interested in the causes, effects, and correlates of religious fundamentalism (Brandt and Reyna 2010; Emerson and Hartman 2006; Moaddel and Karabenick 2018). While there are many different conceptions of the term, one of the most widely accepted definitions is that fundamentalism is associated with religious exclusivism: the idea that only one's religion is correct and all others are necessarily false (Emerson and Hartman 2006; Moaddel and Karabenick 2018). Intentionally described in general terms, this definition of religious fundamentalism (i.e., primarily as exclusivism) transcends any particular religion or region of the world.

While religious exclusivism superficially has nothing to do with science beliefs, there are reasons to believe that religious exclusivists (or fundamentalists) would be significantly more likely to favor religion given a conflict with science. According to research in cognitive science and psychology, certain people have psychological predispositions that make exclusivist or "fundamentalist" forms of religion more attractive: i.e., a deep or innate need for stability, risk aversion, and a dislike of ambiguity or uncertainty (Brandt and Reyna 2010; Ludeke et al. 2013). The enterprise of science, on the other hand, is always subject to reevaluation based on the availability of new scientific theories and data (Rosenberg 2011); indeed, the use of the scientific method regularly leads to new findings that significantly modify the existing body of scientific knowledge.

As such, I expect religious exclusivism (a proxy for fundamentalism) to be a strong predictor of supporting religion when religion and science are in conflict (H4a). Moreover, I further argue that religious exclusivism should matter more than religiosity (H4b), because the former (or fundamentalism more generally) constitutes an ontological foundation for all downstream attitudes and beliefs (Christiano et al. 2008). For example, in the U.S. context, there are millions of highly religious mainline Protestants and liberal Catholics who frequently attend services yet do not reject scientific findings related to the Big Bang or human evolution (Evans 2018). Put simply, what people believe should matter more than the salience of their membership in any particular group.

> Hypothesis 4: (a) Religious exclusivism is associated with more support for religion, when religion and science are in conflict; (b) moreover, it is a stronger predictor than religiosity.

Existing Literature

Most of the empirical sociological literature related to the conflict narrative, which posits a conflict between religion and science, has focused on the U.S. context (e.g., Baker et al. 2020; Cacciatore et al. 2018; Evans 2013, 2018; Gauchat 2012, 2015; Scheitle et al. 2018; Sherkat 2011, 2017). A major focus of cross-national studies in this literature is on assessing the nature of the relationship between individual-level characteristics (e.g., education, religiosity) and attitudes about science. However, when there are indeed conflicts between religion and science, what kinds of people support religion? How does this vary across countries? I am only aware of one study that directly addresses these questions: Chan (2018). The other comparative studies focus on alternative outcomes: for example, McPhetres et al. (2020), Noy and O'Brien (2019), and Price and Peterson (2016) assess the individual-level and country-level predictors of optimism about science's net effects on human life and/or the world. These outcomes are based on how strongly respondents agree or disagree with statements such as the following (from the World Values Survey, Wave 6): "Science and technology are making our lives healthier, easier, and more comfortable." There are two other cross-national studies that predict how strongly respondents agree or disagree with the following statements: "we believe too often in science, and not enough in feelings and faith" (Evans 2014); and "We trust too much in science and not enough in religious faith" (O'Brien and Noy 2018).

To the best of my knowledge, within this cross-national literature, only Chan (2018) uses as an outcome a question that asks respondents to explicitly indicate whether they support religion given a conflict: "Whenever science and religion conflict, religion is always right." The primary predictor in Chan (2018) is a religiosity measure based on a factor analysis of seven input variables: self-evaluation of religious identity, beliefs about God and hell, subjective ratings of the importance of God and religion, and frequency of prayer and attendance at religious services. In short, the religiosity measure used is heterogenous, representing many dimensions of what it means to be a religious person (Christiano et al. 2008). The author finds that the religiosity coefficient for the science v. religion conflict outcome is negative for all 52 countries in her sample, indicating that across a diverse collection of countries, religious people are more likely to side with religion when religion and science are in conflict (this is related to H3a in the present study).

However, since the analysis in Chan (2018) was designed to address a different research question, we are limited in our abilities to draw more specific inferences about why religious people appear to support religion when religion and science are in conflict.[22] For example, based on the existing literature, we know that religiosity is often positively correlated with fundamentalism (Emerson and Hartman 2006) and negatively correlated with favorable science attitudes (Evans 2014; Price and Peterson 2016). The models used in Chan (2018) included neither a proxy for fundamentalism (i.e., religious exclusivism) nor indicators of science attitudes (optimism, moral concerns). As such, it is unclear whether religiosity (net of these covariates) would still strongly predict support for religion over science given a conflict—or if the association would be significantly weakened (or even reversed) after accounting for the covariance among predictors. Also important, thus far there have been no direct tests of the cultural ascendancy and alienation theses in the cross-national literature (Gauchat 2012).

Data and Methods

The individual-level survey data used in this study come from Waves 6 (2010-2016) and 7 (2017-2020) of the World Values Survey (WVS, Inglehart et al. 2020).[23] The WVS carries out nationally representative surveys on a standard set of social, economic, and political issues in many countries and territories. The final analytic sample includes data from 120,728 individuals across 71 countries/territories: 61,600 individuals in 56 countries/territories in Wave 6, and 59,128 individuals in 48 countries/territories in Wave 7.[24] Some countries were included in both

[22] Rather than test specific hypotheses (as in the present paper), the analytical goal in Chan (2018) is largely exploratory: "Rather than positing specific hypotheses for each outcome, I explore the relationship between religiosity, country religious context, and orientations towards science broadly" (970).
[23] The Wave 6 data are all from 2010-2014, except for Haiti, where the survey was completed in 2016.
[24] The final analytic sample only includes cases with complete information (i.e., no missing data) on the key variables.

waves (e.g., Brazil, China, U.S.). The sample includes a diverse array of societies from eight culturally significant (and distinct) regions of the world: East Asia, Former USSR, Latin America, Middle East and North Africa (MENA), South Asia, Southeast Asia, Sub-Saharan Africa, and the West[25]; for countries/territories by region, see Table A1 in Appendix A. Different subsets of the analytic sample were used in different analyses (e.g., pooled OLS models by region) based on data relevance and availability (details follow).

Outcome Measurement

The outcome used in the analyses is based on a question asking to what extent respondents support religion given a conflict between religion and science. Respondents are asked to indicate how strongly they agree or disagree with the following statement: "Whenever science and religion conflict, religion is always right." There are four answer choices, which were converted to a 1-4 point scale: (1) "Strongly disagree," (2) "Disagree," (3) "Agree," (4) "Strongly agree." A disadvantage of the question phrasing is that it does not specify whether the conflict is over an epistemological or moral claim (Evans 2018), precluding an analysis of whether the effects of the predictors differ based on the type of disagreement involved.

On the other hand, a strength of such a general phrasing is that it makes the question relatable to more people in widely different contexts; after all, the specific nature (or scope) of a conflict between religion and science may vary across countries/territories, religious groups, and

[25] As per convention in the literature, societies in the West are classified together primarily based on cultural similarities (e.g., being relatively wealthy democracies) rather than geography per se. Former USSR states were included if they were EU members at the time of the survey (e.g., Estonia).

religious groups within countries (Alumkal 2017; Christiano et al. 2008). Another strength of the question phrasing is that it asks respondents to consider an explicit conflict between religion and science and then indicate whether they would support religion; only these types of items enable an empirical assessment of whether religion "wins out" given a conflict between these two sources of cultural authority (Gieryn 1999; Oreskes 2019). In contrast, some existing cross-national studies use an item that only indirectly hints at a conflict between the two institutions as the outcome (Evans 2014; O'Brien and Noy 2018).

Key Predictors

This present study assesses the relative (i.e., net) predictive effects of four important social constructs: science optimism, moral concerns about science, religiosity, and religious exclusivism. To operationalize optimism about the effects of science on society, respondent answers to two questions were combined using principal component analysis (PCA). Respondents were asked to indicate how strongly they agreed/disagreed with the following two related statements on a 1-10 point scale, where 1 = "Completely disagree", 10 = "Completely agree": (1) *"Because of science and technology, there will be more opportunities for the next generation"*; (2) *"Science and technology are making our lives healthier, easier, and more comfortable."* The science optimism index was created using the first principal component, or the weighted linear combination of the two input variables representing the most variation in the data (Shlens 2014; see Appendix B). This predictor is used to test Hypothesis 1: cultural ascendancy (Barber 1990; Gauchat 2012).

To measure moral concerns about science's effects on society, I used respondent answers to a question asking how strongly they agreed/disagreed with the following statement: *"One of the bad effects of science is that it breaks down people's ideas of right and wrong."* This item was also measured using the same 1-10 point scale. The intuition is that those expressing moral concerns about modern science (e.g., the ethics of human gene editing, combat drones) are also more likely to be concerned about its risks (e.g., environmental degradation). These moral concerns are related to the alienation thesis described in Hypothesis 2 (Beck 1992; Gauchat 2012; Giddens 1999).

To measure religiosity (net of religious exclusivism), a second index was constructed by combining three related items using PCA and extracting the first principal component (Appendix B). Only WVS items that are generally applicable across most religions are used (e.g., the item about hell was not used). The first item asks respondents to rate the importance of religion to their lives and the responses are coded from 1 ("Not at all important") to 4 ("Very important"). The next two items measure religiosity in terms of its behavioral dimension: one asks about the frequency of participation in religious events or activities, and the other about the frequency of prayer.[26] For attendance, the answer choices are coded from 1 ("Never, practically never") to 7 ("More than once a week"); and for prayer, from 1 ("Never, practically never") to 8 ("Several times a day"). This religiosity index is used to test Hypothesis 3.

To measure religious exclusivism, respondent answers to a question directly capturing their degree of religious exclusivism was used. Respondents were asked to indicate how strongly

[26] The question wording depends on the country context. In many countries, respondents are asked about the frequency of attendance at religious services; however, in the 2018 Thailand survey, the question asks about the frequency of participation in religious activities.

they agreed or disagreed with the following statement: “The only acceptable religion is my religion.” There are four answer choices, which were converted to a 1-4 point scale: (1) “Strongly disagree,” (2) “Disagree,” (3) “Agree,” (4) “Strongly agree.” This item was used to test Hypothesis 4.

In addition, as is standard practice in the relevant cross-national literature (e.g., Chan 2018; Evans 2014; McPhetres et al. 2020, O’Brien and Noy 2018), the models control for individual-level demographic and socioeconomic covariates including age group; gender; income, based on a 1-10 point scale (deciles); university degree (no degree is the reference); and religious group membership (Buddhist, Eastern Orthodox, Hindu, Jewish, Muslim, Other Christian, Other, Protestant, Roman Catholic, Unaffiliated). The reference category for religious group is unaffiliated.[27]

Analytical Methods

The main analyses include two stages. First, to compare the overall (or average) predictive effects of science optimism, moral concerns about science, religiosity, and religious exclusivism, I estimated two-level hierarchical linear models (HLMs) (Raudenbush and Bryk 2002). In total, 112,260 individuals (level 1) are nested within 67 country/territory clusters (level 2); the HLMs are estimated with random intercepts, which allows the intercepts to vary across the level 2

[27] The unaffiliated group is quite heterogeneous: it includes atheists, agnostics, and those who consider themselves to be “spiritual” but not members of any official religion (DiMaggio et al. 2018). The core results are robust to the exclusion of this group (Figure A4, Appendix F).

units.[28] Four societies are excluded in the HLM analyses because of missing level 2 data (Andorra, Hong Kong, Macau, Taiwan). The HLMs are used to estimate the outcome (choosing religion, given a conflict) as a function of the four predictors and controls (e.g., gender, age, education) at level 1. Both the moral concerns about science and religious exclusivism predictors are standardized (i.e., rescaled to have a mean of 0 and a standard deviation of 1.0). This way, all four key predictors are measured using the same scale and their coefficients are comparable: i.e., the coefficient represents the net change in the outcome due to a one standard deviation change in the predictor.[29] Income scale is group-mean centered.

Each society's intercept is modeled as a function of the following level 2 variables: the society's level of scientific productivity, based on its percentile rank of scientific and technological journal articles per capita (World Bank)[30]; the society's wealth, based on the percentile rank of GDP per capita adjusted for purchasing power parity (PPP, World Bank); political rights and civil liberties, based on Freedom House scores (free, partly free/not free)[31]; and an indicator for whether the society is Christian-majority, Muslim-majority, or neither.[32] The reference groups are "partly free or not free" and "neither," respectively. Where possible, missing level 2 data were imputed using data from the nearest year. Both continuous level 2

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[28] If country/territory-year clusters are used instead as the level 2 units, the core results are substantively similar.

[29] The input variables for the two other predictors (science optimism index, religiosity index) were standardized before the PCA stage, and thus the resulting indices are comparable in their scale (Appendix B). All of the rescaling for the four predictors were done within each group (i.e., society).

[30] According to the World Bank: *"Scientific and technical journal articles refer to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences."*

[31] Freedom House ratings were used because they are available even for territories, whereas Polity V scores are only available for sovereign states. However, if Polity V scores are used instead (which requires dropping data from territories), the core results are substantively similar.

[32] "Christian" is broadly construed here, to include Protestants, Roman Catholics, etc.

variables were grand-mean centered. However, since the scientific output and wealth percentile ranks are correlated, when one is used, the other is converted into a categorical variable indicating terciles (see Tables 3, 4). For additional details on how the level 2 variables were coded, see Appendix C. Finally, a set of dummies were added for year. Estimation is by restricted maximum likelihood (REML; see Bates et al. 2015).

Second, to assess whether the predictive effects of the two science belief variables differ based on a country's level of economic development and scientific output (i.e., H1b and H2b), I re-estimated the HLM four times. Each included a cross-level interaction between country/territory wealth or scientific output and one of the two science belief predictors (Aguinis et al. 2013). These HLMs are estimated with random slopes for the lower-level component in the cross-level interaction (e.g., science optimism), to ensure proper estimation of the standard errors and t-statistics (Heisig and Schaeffer 2019). For a brief formal exposition of the HLMs in this paper, see Appendix D. To assess whether there are regional variations in these predictive effects (e.g., Western v. non-Western societies per Hypotheses 3 and 4), I also estimated pooled OLS regressions by region.[33] These pooled OLS regressions included the same individual-level predictors and controls as in the HLMs, as well as a set of dummies for country/territory and period (as fixed effects).[34] Robust standard errors were clustered over the country/territory-year cells (Abadie et al. 2017; Blair et al. 2021).

[33] Two countries were included in the main HLM analyses, but excluded from the pooled OLS analyses by region because they do not fit into any of these eight regions: Serbia, Trinidad and Tobago.
[34] Year fixed effects are not used, because of collinearity with country/territory fixed effects. There are five periods, each covering two years: 2010-2011, 2012-2013, 2014/2016, 2017-2018, 2019-2020. For two regions (Former USSR, Latin America) only, even this period variable caused collinearity issues, so a two-period dummy was used: 2010-2014, 2016-2020.

All analyses described above use the recommended sampling weights, which account for both within-country sampling designs (unequal propensities of selection) and differences in sample sizes across countries/territories (Medrano n.d.). For more details, see Appendix E. The results are substantively similar when sampling weights are not used.

Table 1 displays the summary statistics for the individual-level variables in the full analytic sample. Table 2 displays the summary statistics for the country/territory-level (level 2) variables used in the HLMs.

Table 1: Summary Statistics for the Individual-Level Variables

Variables	**N**	**Mean (UW)**	**Mean (W)**	**SD**	**Min**	**Max**
Choose Religion Given a Conflict	120,728	2.6	2.6	1.0	1	4
Components: Science Optimism						
ST Creates More Opportunities	120,728	7.7	7.7	2.3	1	10
ST Improves Lives	120,728	7.5	7.6	2.4	1	10
Moral Concerns w/ Science	120,728	5.5	5.4	2.8	1	10
Religious Exclusivism	120,728	2.5	2.5	1.1	1	4
Components: Religiosity						
Importance of Religion	120,728	3.1	3.1	1.0	1	4
Religious Activities	120,728	4.0	3.9	2.2	1	7
Frequency of Prayer	120,728	5.5	5.4	2.7	1	8
Religious Group	120,728					
Buddhist		5.2%	5.1%			
Eastern Orthodox		9.2%	12.3%			
Hindu		2.4%	1.9%			
Jewish		0.2%	0.2%			
Muslim		27.6%	27.2%			
Protestant		9.1%	8.6%			
Roman Catholic		20.1%	20.4%			
Other Christian		3.8%	3.5%			
Other		2.9%	2.7%			
Unaffiliated		19.4%	18.2%			
Age Group	120,728					
18 to 30		31.1%	31.9%			
31-45		30.6%	30.3%			

46-60		23.7%	22.9%			
61 and above		14.6%	14.9%			
Male	120,728	48.5%	49.0%			
University Degree	120,728	21.2%	20.0%			
Income Scale	120,728	4.9	4.8	2.1	1	10

Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 120,728 individuals
Notes: Unweighted and weighted means/proportions are displayed, respectively. To illustrate the original distributions of the quantitative variables, none of them have been standardized or rescaled.

Table 2: Summary Statistics for the Country/Territory-Level Variables

Variables	**N**	**Mean or %**	**SD**	**Min**	**Max**
Scientific/Technological Journal Articles per 1,000	67	0.4	0.6	0.00301	2.1
GDP per Capita (PPP, constant dollars)	67	18,891	15,502	1,490	82,065
Civil Liberties and Political Rights	67				
Free		40.3%			
Partly Free or Not Free		59.7%			
Religious Composition	67				
Christian-majority		52.2%			
Muslim-majority		28.4%			
Neither		19.4%			

Source: World Values Survey, Waves 6 and 7 (2010-2020); N = 67 countries/territories
Notes: To illustrate the original distributions of the quantitative variables, none of them have been standardized or rescaled.

Results

Hypothesis 1a (cultural ascendancy) predicts that optimism about the effects of science on society is associated with less support for religion when religion and science are in conflict. The results from the first set of HLMs are displayed in Table 3. Overall (i.e., on average across 67 countries/territories), science optimism does indeed predict less support for religion, given a conflict (Models 1-4, Table 3). However, on average, the substantive effect is small: a one standard deviation (1 SD) increase in science optimism is associated with less than a 1% reduction in support for religion over science, compared to the global mean level of support (Model 4, Table 3). Hypothesis 2a (alienation) predicts that moral concerns about the effects of science on society are associated with more support for religion when religion and science are in conflict. This prediction is also supported by the HLM results in Table 3. However, on average, the predictive effect is again relatively small: a 1 SD increase in moral concerns about science is associated with a 2% increase in support for religion given a conflict, net of covariates (Model 4, Table 3).

Table 3: HLMs Predicting Support for Religion Over Science, Given a Conflict

	DV: Given Conflict, Choose Religion over Science			
	(1)	(2)	(3)	(4)
Individual-level				
Science Optimism	-0.03***	-0.03***	-0.03***	-0.02***
	(0.002)	(0.002)	(0.002)	(0.002)
Moral Concerns about Science		0.09***	0.08***	0.06***
		(0.002)	(0.002)	(0.002)
Religiosity			0.17***	0.13***
			(0.002)	(0.002)
Religious Exclusivism				0.28***
				(0.002)
Buddhist	0.18***	0.17***	0.002	-0.04*
	(0.02)	(0.02)	(0.02)	(0.02)
Eastern Orthodox	0.44***	0.42***	0.15***	0.11***
	(0.01)	(0.01)	(0.01)	(0.01)
Hindu	0.39***	0.37***	0.12***	0.09***
	(0.03)	(0.03)	(0.02)	(0.02)

Jewish	0.27***	0.27***	0.13*	0.08
	(0.06)	(0.06)	(0.06)	(0.05)
Muslim	0.66***	0.64***	0.33***	0.22***
	(0.01)	(0.01)	(0.01)	(0.01)
Protestant	0.47***	0.45***	0.15***	0.11***
	(0.01)	(0.01)	(0.01)	(0.01)
Roman Catholic	0.36***	0.34***	0.08***	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)
Individual-level controls	yes	yes	yes	yes
Country-level				
Free Society	0.08	0.08	0.11	0.10
	(0.14)	(0.14)	(0.15)	(0.15)
Christian-majority	0.05	0.05	0.14	0.15
	(0.14)	(0.14)	(0.14)	(0.15)
Muslim-majority	0.44**	0.45**	0.61***	0.68***
	(0.16)	(0.16)	(0.17)	(0.17)
Country Wealth: Bottom Tercile	0.18	0.18	0.20	0.21
	(0.16)	(0.16)	(0.17)	(0.17)
Country Wealth: Top Tercile	-0.22	-0.22	-0.23	-0.24
	(0.16)	(0.16)	(0.16)	(0.17)
Scientific Output Percentile Rank	-0.01	-0.01	-0.01	-0.01
	(0.003)	(0.004)	(0.004)	(0.004)
Observations	114,018	114,018	114,018	114,018
Countries/Territories	67	67	67	67
Log Likelihood	-146,120.50	-145,318.70	-141,249.60	-133,745.40
Bayesian Inf. Crit.	292,636.90	291,045.00	282,918.30	267,921.60

Source: World Values Survey, 2010-2020 (n = 114,018); sampling weights used (Appendix E)
*Notes: Other individual-level controls include age group, gender, income, university education, and year (as dummies). The reference group for individual-level religious affiliation is "None" and the coefficients for "Other Christian" and "Other" are not displayed. Statistical significance: *p<0.05; **p<0.01; ***p<0.001 (two-tailed).*

Hypotheses 1b and 2b suggested that the predictive effects of science optimism and moral concerns about science, respectively, would be amplified in wealthy and scientific societies. To test these predictions, cross-level interactions were included in Models 5-8 (Table 4). The results show that the predictive effects of moral concerns about science are indeed stronger in wealthier and scientific societies (Models 6, 8); but that the predictive effects of science optimism are not significantly moderated by a society's level of wealth or scientific output (Models 5, 7). However, the differences in the predictive effects of moral concerns, while statistically significant, are not substantively large: e.g., 20 percentage point gain in a society's level of wealth or scientific productivity (relative to the mean across all societies), would increase the individual-level coefficient for moral concerns from 0.06 to 0.08. While this constitutes an increase of 33% from the base coefficient value, that still indicates that a 1 SD increase in moral concerns in these wealthier/more scientific societies is associated with only a 3% increase in support for religion over science, given a conflict.

Another way of addressing Hypotheses 1b and 2b is to compare the coefficients of science optimism and science moral concerns between Western societies (which are almost uniformly in the top tercile for both scientific output/wealth) and non-Western societies. A coefficient plot is displayed in Figure 1, based on the results of the pooled OLS regressions by region. The predictive effect of science optimism in Western societies is not significantly different from those in many other regions of the world. In contrast, the predictive effect of moral concerns is indeed significantly larger in Western societies than in every other region of the world except for the Former USSR and Latin America; even still, the coefficient for this predictor in the West is not large (0.10), which indicates that a 1 SD increase in moral concerns about science is associated with a 5% increase in support for religion over science (the mean outcome in Western societies is 1.95).

In sum, substantively, the predictive effects of science optimism (in particular) and moral concerns about science are generally quite small (or at best, mid-sized), even in wealthier and more scientific societies.

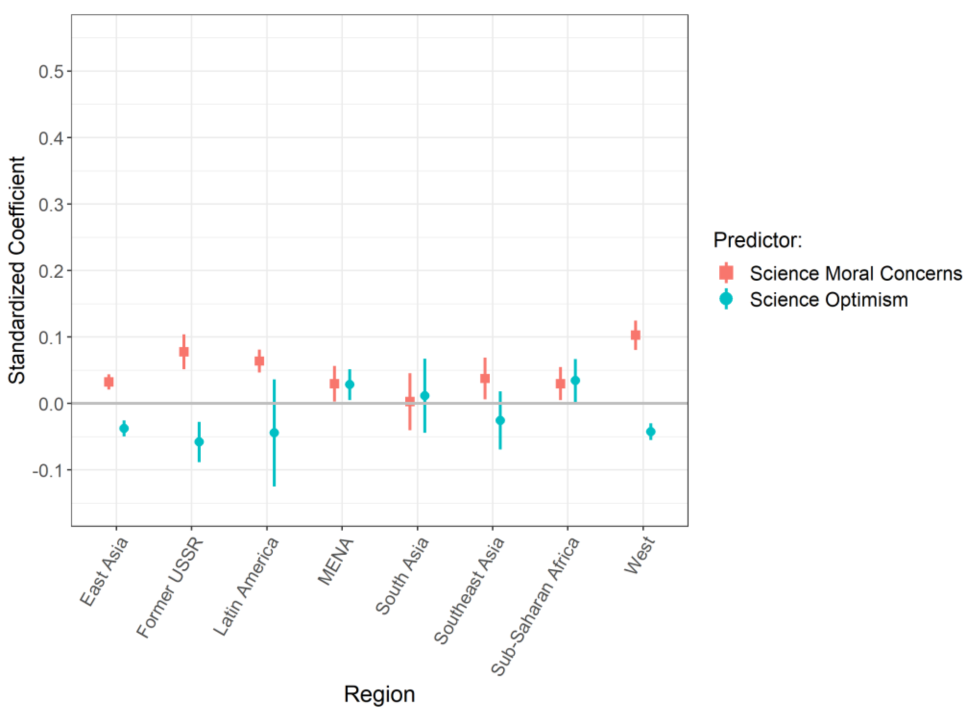
Table 4: HLMs Predicting Support for Religion Over Science, Given a Conflict (Cross-level Interactions)

	DV: Given Conflict, Choose Religion over Science			
	(5)	(6)	(7)	(8)
Individual-level				
Science Optimism	-0.02**	-0.02***	-0.02**	-0.02***
	(0.01)	(0.002)	(0.01)	(0.002)
Moral Concerns about Science	0.06***	0.06***	0.06***	0.06***
	(0.002)	(0.01)	(0.002)	(0.01)
Religiosity	0.13***	0.13***	0.13***	0.13***
	(0.002)	(0.002)	(0.002)	(0.002)
Religious Exclusivism	0.27***	0.27***	0.27***	0.27***
	(0.002)	(0.002)	(0.002)	(0.002)
Individual-level controls	yes	yes	yes	yes
Country-level				
Scientific Output Percentile Rank	-0.01	-0.01*		
	(0.004)	(0.004)		
Country Wealth Percentile Rank			-0.01**	-0.01**
			(0.004)	(0.004)
Country-level controls	yes	yes	yes	yes
Cross-level interactions				
Science Optimism * Scientific Output	-0.0004			
	(0.0003)			

Moral Concerns * Scientific Output		0.001^{***}		
		(0.0002)		
Science Optimism * Country Wealth			-0.001	
			(0.0003)	
Moral Concerns * Country Wealth				0.001^{***}
				(0.0002)
Observations	114,018	114,018	114,018	114,018
Countries/Territories	67	67	67	67
Log Likelihood	-133,041.50	-133,445.50	-133,039.10	-133,438.80
Bayesian Inf. Crit.	266,548.70	267,356.70	266,543.90	267,343.30

Source: World Values Survey, 2010-2020 (n = 114,018); sampling weights used (Appendix E)
Notes: Same individual-level and country-level controls as in Models 1-4 (Table 3). Models 5-6 include controls for country wealth terciles, and Models 7-8 include controls for country scientific output terciles.
Statistical significance: $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$ (two-tailed).

<u>Figure 1: Standardized Coefficients for Science Optimism and Science Moral Concerns from the Pooled OLS Regressions by Region</u>



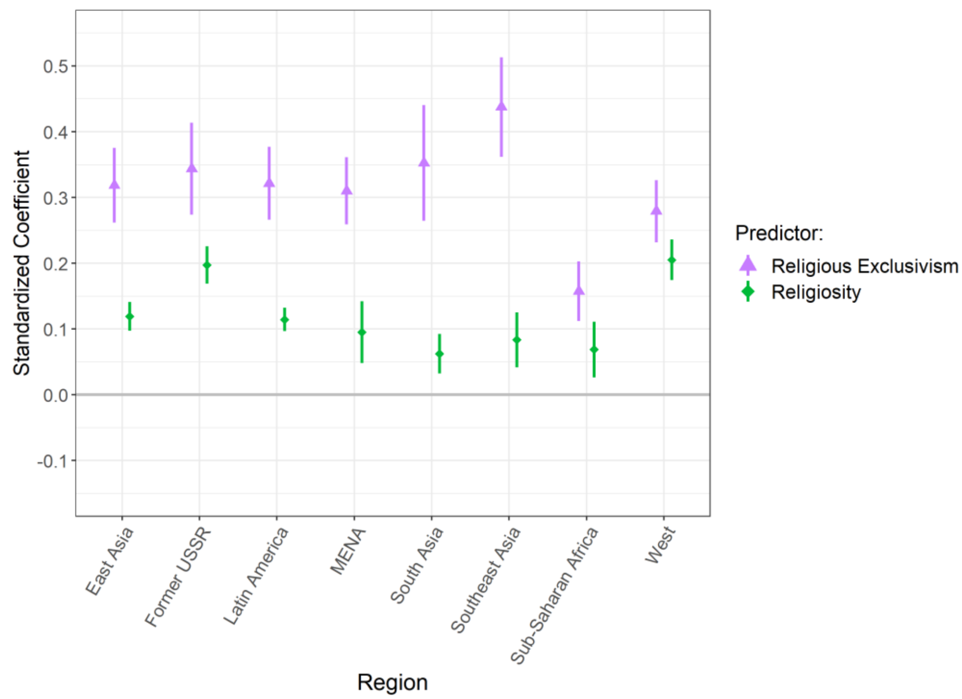
Source: World Values Survey, 2010-2020 (n = 117,377); sampling weights used (Appendix E)

Next, we consider the evidence related to Hypotheses 3 and 4. Hypotheses 3a and 4a predict that religiosity and religious exclusivism, respectively, are associated with more support for religion (when religion and science are in conflict). According to the full baseline model, a 1 SD increase in religiosity is associated with a 5% increase in support for religion over science, a mid-sized effect; while a 1 SD increase in religious exclusivism is associated with a 11% increase in support, a substantively large effect (Model 4, Table 3).

Hypothesis 3b suggests that the predictive effects of religiosity are greater in non-Western societies (per the multiple modernities thesis). To assess this prediction, we can examine the standardized coefficients for religiosity from the pooled OLS regressions by region, which are displayed in Figure 2. There is no support for H3b: there is no region where the predictive effects of religiosity are significantly greater than in the West; in fact, the predictive effects of religiosity are significantly higher in the West than in every region except for the Former USSR.

However, there is strong support for H4b: overall, the predictive effect of religious exclusivism is on average (i.e., across 67 societies) twice as large as that of religiosity; these differences are both substantively and statistically significant (95% CI of [0.272, 0.281] and [0.129, 0.135] respectively). These results also generally hold across different regions of the world: per Figure 2, in every region except for the West, religious exclusivism is a significantly stronger predictor of choosing religion over science than religiosity.

Figure 2: Standardized Coefficients for Religious Exclusivism and Religiosity from the Pooled OLS Regressions by Region



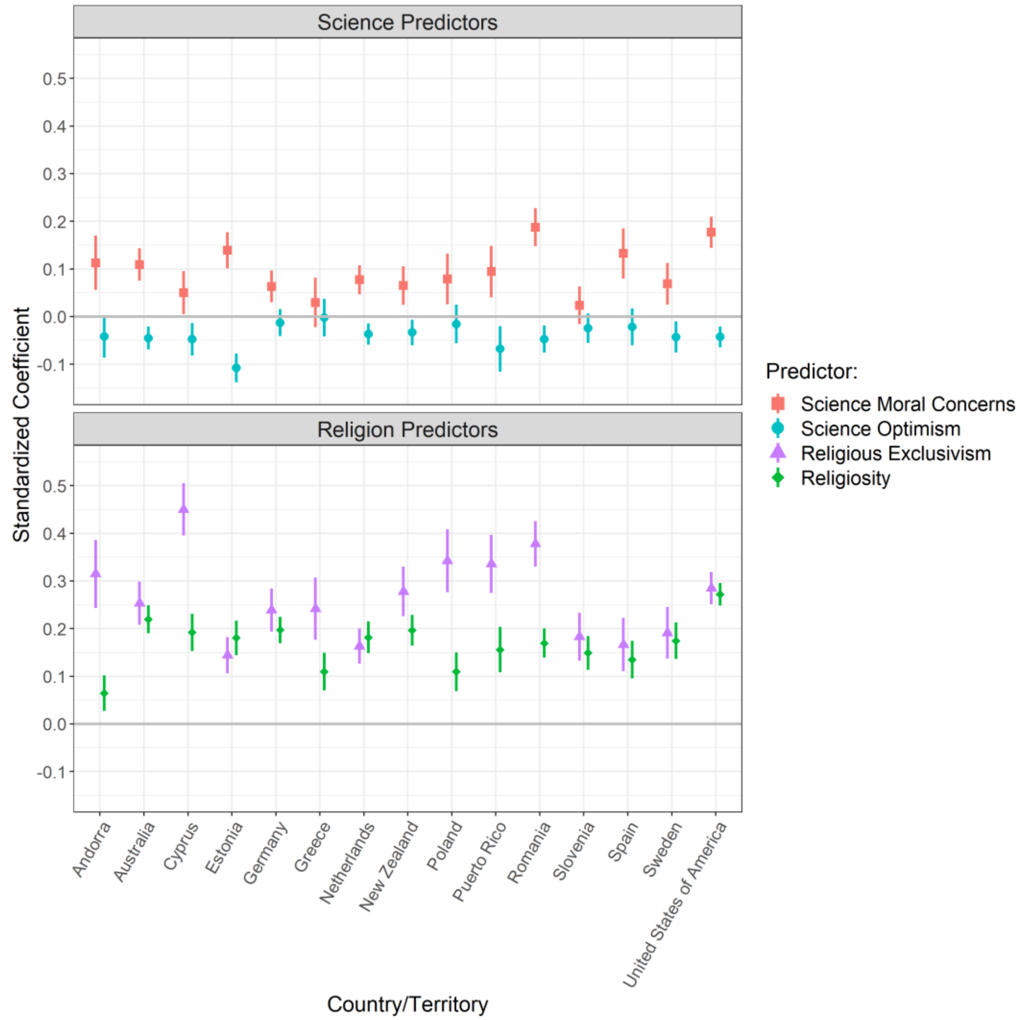
Source: World Values Survey, 2010-2020 (n = 117,377); sampling weights used (Appendix E)

Overall, among the four key predictors of interest in this study, religious exclusivism is the strongest individual-level predictor of supporting religion over science when the two institutions are in conflict. More generally, the religion variables (i.e., exclusivism and religiosity) are stronger predictors of the outcome than science attitudes or beliefs. Figures 1 and 2 are displayed using the same scale on the y-axis, which enables readers to see that this is largely consistent across various regions of the world.

Robustness Checks

As robustness checks, supplementary analyses were conducted to assess whether there are important exceptions to the general trends discussed above. In general, the supplementary results are largely consistent with the main findings. First, separate pooled OLS regressions by country/territory were estimated with robust standard errors (Blair et al. 2021). The results for Western societies, which tend to have higher wealth and scientific output, are of particular interest: i.e., although science optimism does not have a substantively large effect on average across the region (Figure 1), are there a few Western countries/territories where the predictive effects are large? Figure 3 displays the standardized coefficients for the four key predictors in 15 Western societies (e.g., EU members), and we can see that the coefficient for science optimism is near zero in most cases (e.g., in Australia, Germany, Sweden, Netherlands, New Zealand), and never substantively large. Even in relatively wealthy and technologically advanced Western societies, religion (particularly religious exclusivism) matters more than science beliefs when it comes to conflicts between the two institutions.

Figure 3: Standardized Coefficients for Key Predictors from the Pooled OLS Regressions by Country/Territory (Western Societies only)



Source: World Values Survey, 2010-2020 (n = 22,374); sampling weights used (Appendix E)

Figure A3 (Appendix F) displays the standardized coefficients for the four key predictors in 56 non-Western societies. Out of this sample, there is only one society, Haiti, in which the predictive effects of science optimism are substantive large: a 1 SD increase in science optimism is associated with a 15% decrease in support for religion over science given a conflict (net of covariates). In most non-Western societies, religious exclusivism is again the strongest of the four key predictors—and often, by far.

Next, I estimated separate OLS regressions for 10 major religious groups, with dummies for country/territory and period; robust standard errors are clustered over country-year cells. The standardized coefficients for the four key predictors are displayed in Figure A4 (Appendix F). The results for these individual religious groups are largely consistent with the main findings: the science predictors never have substantively large effects, and religious exclusivism usually matters more than religiosity (except for several groups, where the predictive effects of exclusivism and religiosity are similar).

So far, the analyses have largely focused on comparing predictors of the outcome at the individual-level (e.g., within countries/territories or regions). However, there is also a significant degree of variation across societies in the average outcomes (Figure A2, Appendix A). Does the relative importance of each key predictor change at a higher level of aggregation? Table A3 displays the results of HLMs, with additional country/territory-level predictors that have been added based on the four key-individual level predictors (e.g., a country-level measure of science optimism); for information on how these aggregate level-2 predictors were constructed, see Appendix F. The results again show that the two religion variables are the most significant predictors even when predicting country/territory-level variations in the average outcomes. While the coefficients for the two science predictors are near zero in the final full model (Model 4, Table A3), a 1 SD increase in the religiosity of a country/territory is associated with a 14% increase in support for religion over science; 1 SD increase in the country/territory's level of religious exclusivism is associated with an 8% increase in support for religion.

Discussion

These results have implications for social scientific theories of modernization and secularization, which suggest that economic development is associated with science enjoying more cultural authority—at the expense of religion (Bruce 2011; Inglehart 2018). At the macro-level, the findings suggest that while wealthier societies are indeed significantly less likely to support religion given a conflict, it is not because their populations have greater science optimism (per the cultural ascendancy thesis; Barber 1990, Gauchat 2012); instead, it is because these wealthier societies have lower levels of religiosity and religious exclusivism (see Figure A2, Table A3). Conversely, the continued prominence of religious authority (vis-à-vis science) outside of East Asia and the West has more to do with the lack of secularization in the mass public (Casanova 2011; Possamai 2017) than with moral concerns about the effects of science on society (Evans 2013, 2018; Giddens 1999).

In addition, these findings contribute to the growing literature indicating that the lack of trust in science, particularly in highly developed economies, has less to do with scientific illiteracy (per the deficit model, see Allum et al. 2008); or with being unaware of the achievements of modern science (e.g., Bennett 2019; Sachdev 2014). Instead, mistrust in science (or having a highly conditional form of trust in science) is primarily a social and cultural phenomenon (Gauchat 2012; Evans 2013). For example, recent research in the U.S. shows that ideological conservatives think highly of scientific research but are less favorably inclined toward mainstream scientists, who are perceived as seeking to advance personal agendas (Mann and Schleifer 2020). This may explain why science optimism has weak predictive effects broadly across wealthy, highly scientific societies of the West (Figure 3); perhaps due to the politicization of science, the structural correlates of modernization (e.g., country wealth) do not necessarily amplify the link between individual-level science beliefs and trust in science (Oreskes 2019; Otto 2016).

Another major finding is that while science beliefs are not substantively significant predictors of choosing religion over science (given a conflict), religious exclusivism often is. In fact, religious exclusivism is a significantly stronger predictor than even religiosity (about twice as strong on average). Existing studies in this cross-national literature tend to focus more on the role of religiosity or religious group membership (e.g., Chan 2018; McPhetres et al. 2020; O'Brien and Noy 2018). However, recent research in the U.S. has shown that more than being religious per se, having a particularly conservative religious orientation (e.g., biblical literalism, fundamentalism) is associated with lower scientific literacy, trust in science, and willingness to accept major scientific findings (Drummond and Fischhoff 2017; Evans 2013; Sherkat 2011, 2017). The results in the present study indicate that some of these U.S.-based findings might be broadly generalizable: indeed, in every region except for Sub-Saharan Africa, religious exclusivism (a key dimension of fundamentalism) is a stronger predictor than religiosity (Figure 2).

The study has certain limitations that should be acknowledged. First, the survey item used as the outcome does not specify the nature of the hypothetical conflict between religion and science (e.g., epistemological v. moral; Evans 2013, 2018). The link between science beliefs and the outcome could conceivably vary based on the type of conflict involved. Second, I emphasized throughout this paper that the goal is estimating predictive effects, because the nature of the observational data here makes causal inference more difficult. Future cross-national work could address these limitations by adjusting the questions/answer choices, adding items about the perceived integrity of scientists, and employing survey experimental designs. Nonetheless, the study presents novel findings that contribute to our understanding of how people in 71 diverse societies think about the cultural authority of science—particularly when it is challenged by another highly prominent source of authority (Alumkal 2017). Despite the remarkable achievements of modern science, conservative religious orientations continue to structure how mass publics think about key religio-scientific debates in many regions of the world.

Supplemental Materials

Appendix A: More Information about Regions in the Study

Table A1: List of Countries/Territories by Region

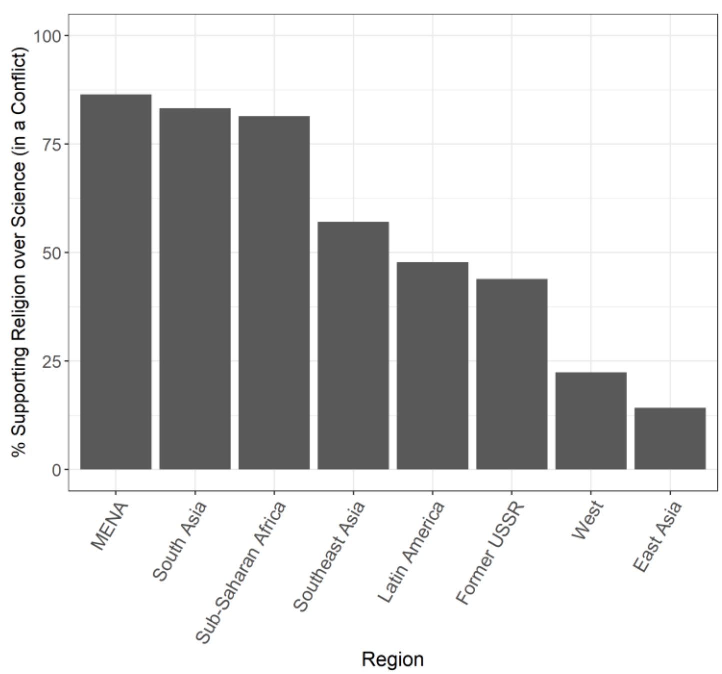
Region	**List of Countries/Territories[35]**	**Total Number**
East Asia	China, *Hong Kong SAR, Japan, *Macau SAR, South Korea, *Taiwan ROC	6
Former USSR	Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Russia, Tajikistan, Ukraine, Uzbekistan	10
Latin America	Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guatemala, Haiti, Mexico, Nicaragua, Peru, Uruguay	12

[35] SAR stands for special administrative region; ROC stands for Republic of China. The full dataset from Wave 6 includes 60 countries/territories and the full dataset from Wave 7 includes 49; across both waves, a few countries were excluded from the analyses because of missing data.

Middle East and North Africa (MENA)	Algeria, Iran, Iraq, Jordan, Lebanon, Libya, Palestine, Tunisia, Turkey, Yemen	10
South Asia	Bangladesh, India, Pakistan	3
Southeast Asia	Indonesia, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam	7
Sub-Saharan Africa	Ethiopia, Ghana, Nigeria, Rwanda, South Africa, Zimbabwe	6
West	*Andorra, Australia, Cyprus, Estonia, Germany, Greece, Netherlands, New Zealand, Poland, Puerto Rico, Romania, Slovenia, Spain, Sweden, United States	15
Other (Not Categorized)[36]	Serbia, Trinidad and Tobago	2

*Notes: *The following societies were included in the pooled OLS regressions but not in the HLM analyses: Andorra, Hong Kong SAR, Macau SAR, Taiwan ROC. The reason is that they are missing data for the required (level 2) covariates.*

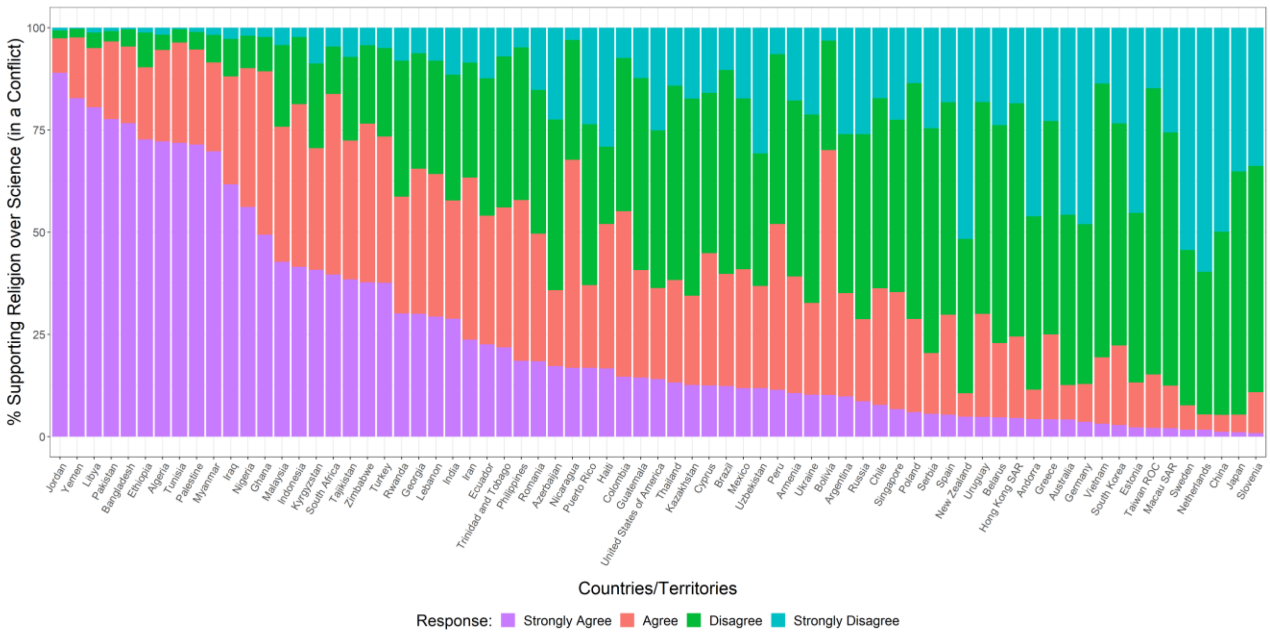
Figure A1: Percentage Supporting Religion Over Science Given a Conflict by Region



[36] These two countries did not fit easily into any of the existing eight regions. They were included in the HLM analyses and the pooled OLS analyses—except for the pooled OLS regressions by region.

Source: World Values Survey, 2010-2020 (n = 117,377); sampling weights used (Appendix E)

<u>Figure A2: Distribution of Average Outcome Responses Across Countries/Territories</u>



Source: World Values Survey, 2010-2020 (n = 118,956); sampling weights used (Appendix E)

Appendix B: Index Construction using PCA at the Individual-level

This appendix contains more details about how the indices were created using principal component analysis (PCA). PCA performs linear transformations of multiple input variables to more efficiently represent their variance in a smaller number of uncorrelated components (or "principal components"): i.e., the first principal component represents the most variation in the data, the second principal component represents the second most variation in the data, and so on

(Shlens 2014; Vyas and Kumaranayak 2006).[37] At the individual level, PCA is used to create a science optimism index and a religiosity index using two and three input variables, respectively. For both indices, the first principal component (PC1) from the PCA is used.

(1) Science Optimism Index

As indicated in the main manuscript, respondent answers to two questions asking them to indicate how strongly they agree/disagree with the following statements were used: (1) *"Because of science and technology, there will be more opportunities for the next generation"*; (2) *"Science and technology are making our lives healthier, easier, and more comfortable."* Both of these items are broadly measures of the respondents' optimism about the effects of science on society.

The following procedure was performed separately by country/territory: after standardizing the input variables (i.e., to have a mean of 0 and SD of 1), PCA was used to compute PC1. This first principal component was used to create the science optimism index. The Pearson correlation coefficient (PCC) for the two input variables ("more opportunities" and "improving lives") is 0.63; the PCC between each input and the final science optimism index is 0.86 for each pair. In sum, the PCCs indicate that these two items are highly correlated with each other as well as with the resulting index, which is a good sign of measurement validity.

[37] More precisely, each principal component is a weighted linear combination of the original input variables. The weights are based on eigenvectors of the covariance matrix, and are computed such that the principal components are orthogonal to (or uncorrelated with) each other.

The PCC is a standardized measure of how much two random variables move together (linearly). It is defined as the covariance between two random variables divided by the product of their standard deviations.

$$p_{a,b} = \frac{cov(a,b)}{\sigma_a \sigma_b}$$

The inclusion of a third potentially relevant item was considered. The prompt for the question is below:

> *"All things considered, would you say that the world is better off, or worse off, because of science and technology? Please tell me which comes closest to your view on this scale: 1 means that 'the world is a lot worse off,' and 10 means that 'the world is a lot better off.'*

When this item ("All things considered") is included in the final science optimism index, the results are substantively very similar—so whether it is included or not, there is no practical difference.

However, in the main analyses, it was excluded for a few reasons. First, the pairwise PCC between this item and each of the other two items was significantly lower than the PCC of 0.63 between the final two inputs ("more opportunities" and "improving lives"). Second, the final two inputs are a part of the same series of questions with the same scale, with 1 = "Completely disagree" and 10 = "Completely agree." For these two items, respondents are being asked whether they agree (or disagree) that science has had a positive effect on society; they are not being explicitly asked to consider some of the negative impacts of science. In contrast, the third item does ask respondents to weigh the relative benefits and costs of science and technology ("All things considered…").

(2) Religiosity Index

As indicated in the main manuscript, the religiosity index was created by using PCA to combine three variables: importance of religion in daily life, frequency of prayer, frequency of attendance at religious services. The PCC for each pair of religiosity inputs ranged from 0.50 (between religious attendance and religiosity) and 0.62 (religious attendance and prayer). The PCC between each religiosity input and the final religiosity index ranged from 0.51 (religiosity) to 0.69 (religious attendance).

In sum, the PCCs indicate that the three input items are highly correlated with each other as well as with the resulting index.

Appendix C: Country/Territory Level Covariates

(1) Coding or Computing Level 2 Covariate Values

In the HLM analyses in the main text (Tables 3 and 4), there were four level 2 variables: *"the society's level of scientific productivity, based on its percentile rank of scientific and technological journal articles per capita (World Bank)*[38]*; the society's wealth, based on the percentile rank of GDP per capita adjusted for purchasing power parity (PPP, World Bank); political rights and civil liberties, based on Freedom House scores (free, partly free/not free); and an indicator for whether the society is Christian-majority, Muslim-majority, or neither."* The first two are continuous variables, and the last two are categorical variables.

The two percentile rank variables were computed in similar ways. I created a dataset where the unit of analysis was country/territory. The values for two initial variables (GDP per capita, PPP; scientific articles per capita) were coded by using the World Bank data from the year the survey was fielded in each particular society (e.g., Ecuador in 2018); if a survey was fielded in a society twice (i.e., in Waves 6 and 7), then the values were averaged (e.g., the number of scientific articles per capita in the U.S. in 2011 and in 2017). Next, the values for each variable were arranged from highest to lowest, and then the percentile ranks were assigned (with a higher percentile indicating greater wealth/scientific output). Finally, both country/territory-level continuous variables were grand-mean centered (Raudenbush and Bryk 2002). However, since the scientific output and wealth percentile ranks are correlated, when one is used, the other is converted into a categorical variable indicating terciles (in the main text, see Tables 3 and 4; also see Table A3 in Appendix F).

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[38] Alterative measures of scientific output are available (e.g., number of registered patents), but data missingness is simply too high for those alternatives to be used. The annual output of scientific articles (once adjusted for population differences) offers a good proxy or indicator of the society's relative scientific productivity—and is correlated with other measures of scientific output such as patents.

To create the indicator for whether the society is "free," civil liberties (CL) and political rights (PR) scores from Freedom House were used: both are measured on a 1-7 scale, with lower scores indicating a higher degree of freedom. First, for each country/territory, I collected the CL and PR scores from the year the WVS survey was fielded in that country/territory; as before, if a society appeared in both waves, the scores from the two waves were averaged (e.g., CL and PR scores for the U.S. in 2011 and 2017). Next, following Freedom House guidelines, the CL and PR scores were averaged and converted into one of the following three categories: "free" if the index is less than 3.0, "partly free" if the index is between 3.0 and 5.0, and "not free" if the index is greater than 5.0. To estimate more parsimonious models, and since the level of a society's freedom is not central to the paper, the last two categories were combined and used as the reference category.

To create the fourth level 2 covariate, a new broader religious group variable was created at the individual level: Christian (all types), Muslim, and Other. Next, the data were pooled across the waves by country/territory, and then the weighted proportion in each of the three broader religious groups were computed; to adjust for sampling design, the original sampling weights provided by each country were used (Appendix E). Finally, each country/territory was coded as being Christian-majority, Muslim-majority, or neither.

There are alternative ways of coding these four level 2 covariates, but the core results are generally robust to these alternatives.

(2) Handling Missing Data

It takes time for organizations such as the World Bank and Freedom House to collect, clean, and release their data—with the time (or lag) often varying by variable type. The last time the data were downloaded for this study was in May 2021. At that time, the most recent year for which the World Bank data were available for most countries was as follows: GDP per capita, PPP (2019); population (2019); number of scientific and technological articles published in journals (2018). The surveys for WVS Wave 7 were conducted in 2019 and 2020 in some countries. In cases where the data were not available for a particular country/territory in the year of the WVS survey, the data from the most recent year were used. For example, assume that the WVS was conducted in a country/territory in 2020; while the GDP per capita (PPP) data were not available for 2020, they are available for 2019, so the data from 2019 were used.[39] A similar imputation method was used for the few cases where data from Freedom House were not available for a particular country/territory-year: the data from the most recent available year were used.

Appendix D: A Brief Formal Exposition of the HLMs in the Paper

<u>(1) Random Intercepts Model</u>

Formally, we can model the outcome for the ith individual in society j as follows (for general references on notation, see Aguinis et al. 2013; Raudenbush and Bryk 2002):

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[39] This approach tends to be quite reliable, since the covariates for a particular society (e.g., level of freedom, GDP per capita) do not change very much over a short period of time (e.g., between 2015 and 2017).

$$Y_{ij} = \beta_{0j} + \sum_{1}^{k} \beta_{kj} X_{kij} + r_{ij}$$

First, let k equal the total number of level-1 predictors and controls. β_{0j} is the intercept for society j, β_{kj} is the coefficient for the kth level-1 predictor (e.g., science optimism) in society j, X_{kij} is the value of the kth level-1 predictor for individual i in society j, and r_{ij} is the residual term associated with individual i in society j. HLM assumes that r_{ij} is normally distributed with mean of 0 and a variance of σ^2: $r_{ij} \sim N(0, \sigma^2)$.

Also, it is important to note that the values of continuous level-1 predictors and controls (e.g., income decile) have been group-mean centered: $\left(X_{kij} - \bar{X}_{kj}\right)$.

Note that β_{0j}, the intercept for society j, is itself a function of another equation. In the equation below, let m represent the number of predictors and controls at level-2 (country/territory-level). Here, γ_{00} is the average of the society means on the outcome, β_m is the coefficient for the mth level-2 predictor, and W_{mj} is the value of the mth level-2 predictor for society j, and u_{0j} is the residual term associated with society j. Note that $u_{0j} \sim N(0, \tau_{00})$

$$\beta_{0j} = \gamma_{00} + \sum_{1}^{m} \beta_m W_{mj} + u_{0j}$$

More intuitively, we can think of $\sum_1^m \beta_m W_{mj}$ as representing the systematic deviation from the global mean γ_{00} in society j as a function of its m level-2 predictors. Moreover, u_{0j} captures the residual variance (i.e., the deviation of β_{0j} from γ_{00}) that is not explained by the m level-2 predictors. Also, it is important to note that continuous level-2 predictors such as society wealth have been grand-mean centered: $(W_{mj} - \overline{W}_m)$.

Next, we can consider β_{kj}, the coefficient for the kth level-1 predictor in society j. In the equation below, γ_{k0} is the average regression slope for the kth level-1 predictor (e.g., science optimism) across all societies. In a simpler random intercepts model with no cross-level interaction, we simply set β_{kj} equal to γ_{k0}. In other words, we do not let β_{kj} vary across societies, as evidenced by the lack of a corresponding residual term u_{kj} (which would represent the deviation of the regression slope for the kth level-1 predictor in society j from γ_{k0}).

$$\beta_{kj} = \gamma_{k0}$$

<u>(2) HLM with Cross-Level Interactions</u>

To estimate an HLM with a cross-level interaction, a few adjustments are made to β_{kj}. Here, for simplicity, assume that k refers to one of the two key science belief level-1 predictors for which a cross-level interaction with society wealth or scientific productivity is estimated: science optimism and moral concerns about science (both group-mean centered).

First, the residual term for the kth level-1 predictor in society j is added (u_{kj}), which allows the regression slope to vary across societies (i.e., a random slopes HLM). A recent simulation study showed that to ensure proper estimation of the standard errors for a cross-level interaction, HLMs should be estimated with random slopes for the lower-level component in the interaction (Heisig and Schaeffer 2019).

Second, the coefficient of the cross-level interaction term is added: γ_{k1}, which indicates the marginal change in β_{kj} given a one-unit change in the society wealth or scientific output (grand-mean centered). In the equation below, for illustrative purposes, we assume that the higher-level component is society wealth. In sum, given a cross-level interaction, we let the regression slope for the kth level-1 predictor in society j vary as a function of: (1) the average regression slope for that level-1 predictor across all societies; (2) γ_{k1} and the society's wealth or scientific output (grand-mean centered); (3) and the residual term u_{kj}, which captures the remaining deviation from γ_{k0} after accounting for the previous two components. Note that $u_{kj} \sim N(0, \tau_{kk})$

$$\beta_{kj} = \gamma_{k0} + \gamma_{k1}(W_{GDP,j} - \bar{W}_{GDP}) + u_{kj}$$

Appendix E: Sampling Weights

S017 is the original WVS weight variable provided by the countries that adjust for country-specific sampling designs: i.e., respondents who are underrepresented relative to their true proportion in the population (e.g., based on race/ethnicity, age) receive a weight above 1.0 while those who are overrepresented receive a weight below 1.0 (Medrano n.d.). The magnitude of S017 represents the extent to which the respondent is under or overrepresented. The final weights used in the main analyses further adjust for differences in sample sizes across countries/territories by dividing each respondent's S017 weight by 1500.

These final weights are designed to account for both unequal probabilities of selection within each country and also differences across countries in sample size. Below, w_{ij} refers to the final weight for the ith respondent in country/territory j, and $S017_{ij}$ refers to the value of the original country weight variable for the ith respondent in country/territory j.

$$w_{ij} = \frac{S017_{ij}}{1500}$$

Note that the sum of w_{ij} within each country/territory always equals 1500. This weight variable is used in all analyses (i.e., all HLMs and pooled OLS regressions) with one exception: for the supplementary analyses where respondents are pooled by country/territory (see Figure 3 in the main text and Figure A3 in Appendix F), the original country weight $S017_{ij}$ is used.

Appendix F: Supplementary Analyses

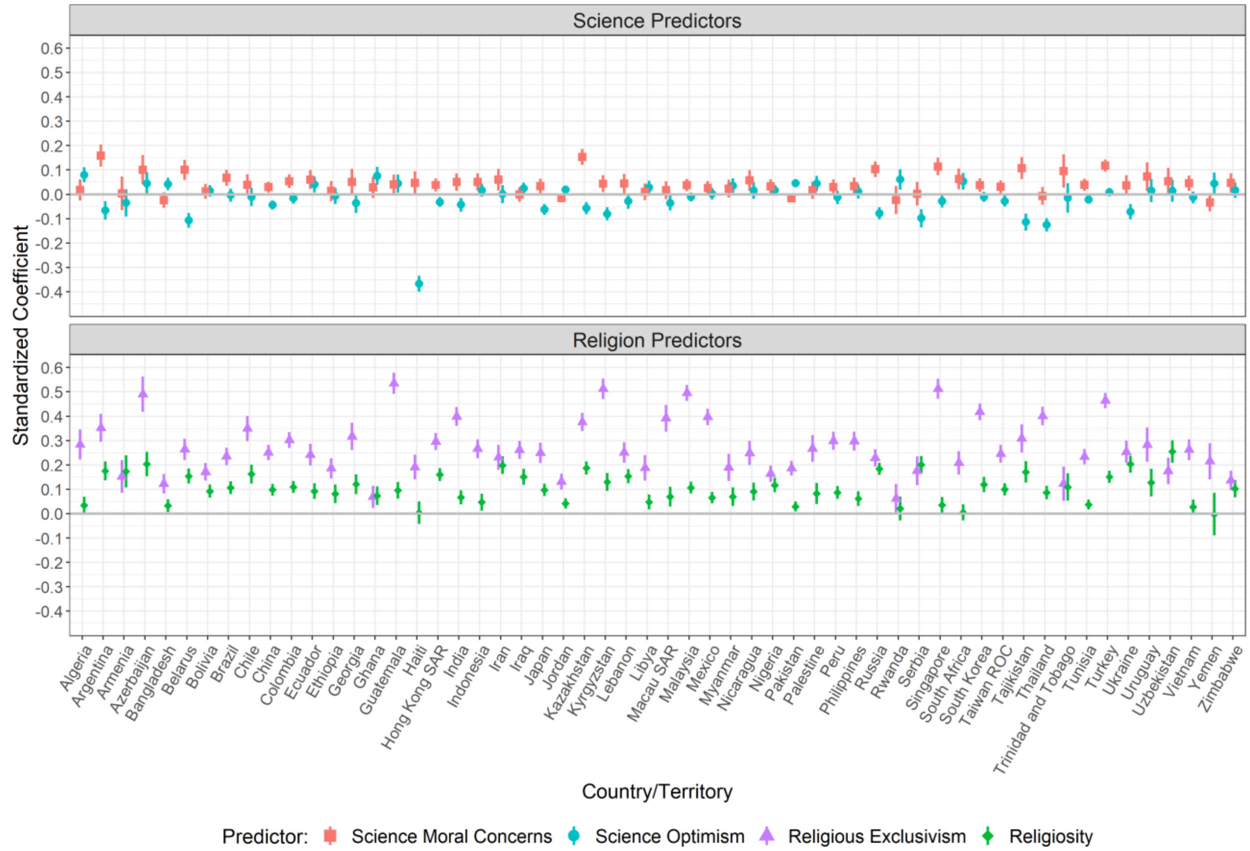
The results from three different sets of robustness checks are discussed below. The results are generally consistent with the core findings in the main text.

(1) Pooled OLS Regressions by Country/Territory

First, separate pooled OLS regressions by country/territory were estimated with robust standard errors ("HC2", Blair et al. 2021). The OLS regressions use the same individual-level predictors and controls as in the main HLMs (Tables 3 and 4, main text).[40] When the society is in both Waves 6 and 7, a dummy is included for year. The standardized coefficients for the four key predictors among 15 Western societies are displayed in Figure 3 (main text); the coefficients for the 56 non-Western societies are displayed below in Figure A3.

Figure A3: Standardized Coefficients for Key Predictors from Pooled OLS Regressions by Country/Territory (Non-Western)

[40] The analytic sample for one society (Yemen) only includes members of a single religious group, so there is no categorical variable for religious affiliation in this model. Also, to ensure that robust standard errors could be computed properly, all ultra-small minority religious groups (where the weighted proportion of the group is <2% of the country/territory sample were re-coded as "Other"). This only applies to the pooled OLS regressions by country/territory.



Source: World Values Survey, 2010-2020 (n = 96,582); sampling weights used (Appendix E)

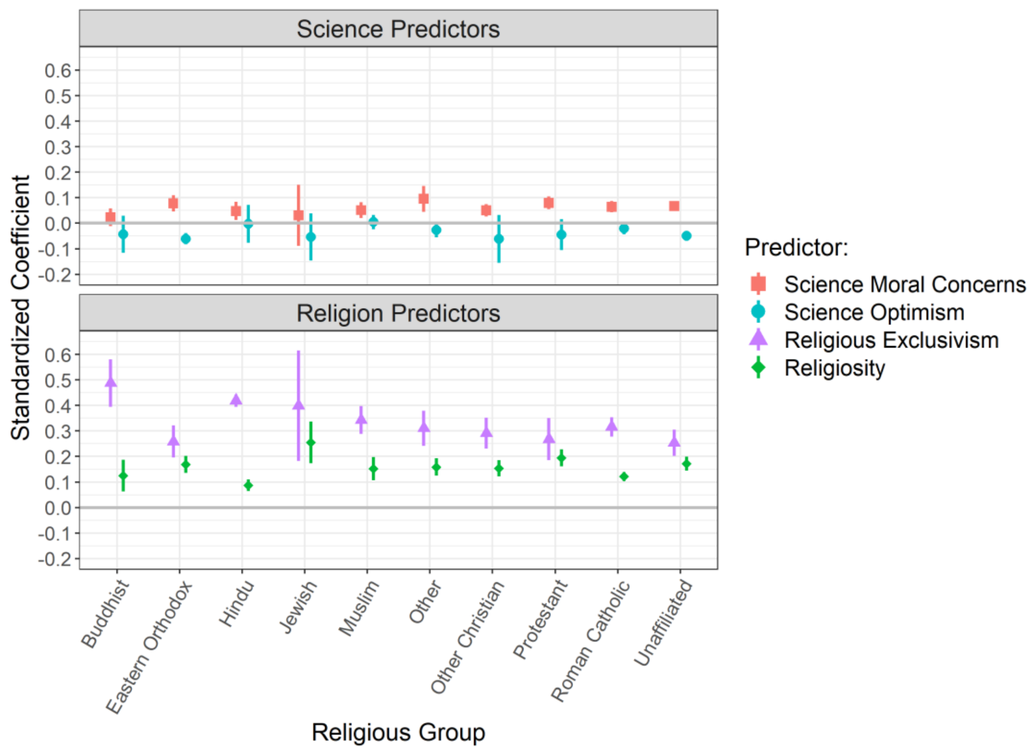
<u>(2) Pooled OLS Regressions by Religious Group</u>

Next, I estimated separate OLS regressions for 10 major religious groups, with dummies for country/territory and period; robust standard errors are clustered over country-year cells.[41] These

[41] An alternative method is to fit four separate HLMs, each of which includes an interaction term between the religious groups and one of the four key predictors. The disadvantage of this approach is that the interpretation of the interaction effect is considerably less intuitive: we would have to interpret the interaction in relation to the reference religious group.

models use the same individual-level predictors and controls as the main HLMs. The standardized coefficients for the four key predictors are displayed below in Figure A4.

Figure A4: Standardized Coefficients for Key Predictors from Pooled OLS Regressions by Religious Group



Source: World Values Survey, 2010-2020 (n = 118,956); sampling weights used (Appendix E)

(3) HLM Analyses with Additional Level-2 Predictors

Finally, I assess whether the core results regarding the four key predictors are affected if they are used to predict variations in the outcome (means) at the country/territory level. To do this, four new country/territory level variables were constructed based on the four key individual-level predictors: science optimism, moral concerns about science, religiosity, and religious exclusivism. All four new predictors described next are continuous variables, and are thus grand-mean centered before being added to the HLMs.

To create the level 2 science optimism predictor, I first computed weighted means of the two relevant individual-level variables by country/territory: (1) beliefs that science and technology will improve human life; (2) beliefs that science and technology create more opportunities for the next generation (for question text, see Appendix B). The weights are based on the sampling weights provided by each country. A single science optimism index was created for each country/territory by taking a simple average of these two science optimism variables.

Similarly, I created the level 2 predictor measuring moral concerns about science by computing the weighted average of the relevant individual-level predictor by country/territory (for question text, see Appendix B).

To create the level 2 religiosity measure for each country/territory, I used the following procedure. First, I created a bootstrap sample for each society by randomly selecting 500 observations (with replacement) from each country/territory's analytic sample. These equally sized country/territory subsamples were combined to create a single, "global" sample (n = 33,500; based on 67 societies); using this sample, I created an individual-level standardized religiosity index by performing PCA and extracting the first principal component. As described before in Appendix B, three input variables were used: importance of religion in daily life, frequency of prayer, frequency of attendance at religious services. Next, the respondents in the global sample were arranged in ascending order of religiosity, and percentile ranks were assigned. Finally, the average percentile rank was computed by country/territory: e.g., an average percentile rank of 80% for society X means that the average respondent in that society is at the 80th percentile of religiosity (relative to counterparts in 67 countries/territories). The advantage of this procedure is that it enables a quantification of the level of religiosity in a society relative to the "global" distribution.

The final new level 2 predictor is based on the weighted average percentage in each society believing that only their religion is acceptable. To compute this measure, I first created a new binary version of the exclusivism variable such that 1 = agrees or strongly agrees that "only my religion is acceptable"; 0 = disagrees or strongly disagrees with that statement. Next, the weighted average of those agreeing or strongly agreeing with that statement is computed for each country/territory.

Table A2 displays the summary statistics for these four new country/territory-level variables for the 67 societies included in the HLM analyses. Table A3 displays the results of the HLMs with additional country/territory-level predictors that have been added based on the four key-individual level predictors. There are, of course, alternative ways to create aggregated level 2 versions of the four key predictors; however, the findings are generally robust to these alternatives.

Table A2: Summary Statistics for the Four Key Level 2 Predictors

Predictor	**N**	**Mean**	**SD**	**Min**	**Max**
Science Optimism	67	7.6	0.6	6.2	9.2
Moral Concerns about Science	67	5.4	0.8	3.9	6.8
Mean Religiosity Percentile Rank	67	50.2	18.5	10.4	84.3
Religious Exclusivism Percentage	67	48.4	27.5	7.1	98.0

Table A3: HLMs Predicting Support for Religion Over Science Given a Conflict (Additional Level-2 Predictors)

	DV: Given Conflict, Choose Religion over Science			
	(1)	(2)	(3)	(4)
Individual-level				
Individual-level predictors	yes	yes	yes	yes
Individual-level controls	yes	yes	yes	yes
Country-level				
Free Society	0.09	0.10	0.10	0.14
	(0.15)	(0.14)	(0.09)	(0.08)
Christian-majority	0.13	0.09	-0.13	-0.13
	(0.15)	(0.13)	(0.09)	(0.08)
Muslim-majority	0.72***	0.72***	0.30**	0.07
	(0.18)	(0.16)	(0.11)	(0.12)
Country Wealth: Bottom Tercile	0.23	0.25	0.08	0.02
	(0.17)	(0.15)	(0.10)	(0.09)
Country Wealth: Top Tercile	-0.22	-0.22	-0.14	-0.07
	(0.17)	(0.15)	(0.10)	(0.09)
Scientific Output Percentile Rank	-0.01	-0.003	-0.001	-0.002
	(0.004)	(0.003)	(0.002)	(0.002)
Country: Science Optimism	-0.12	0.02	0.08	0.02
	(0.11)	(0.11)	(0.07)	(0.07)
Country: Moral Concerns		0.27***	0.10*	0.07
		(0.07)	(0.05)	(0.05)
Country: Religiosity			0.02***	0.02***
			(0.002)	(0.002)
Country: Religious Exclusivism				0.01***
				(0.002)
Observations	114,018	114,018	114,018	114,018
Countries/Territories	67	67	67	67
Log Likelihood	-133,746.10	-133,741.50	-133,720.20	-133,720.00
Bayesian Inf. Crit.	267,934.70	267,937.10	267,906.10	267,917.50

Source: World Values Survey, 2010-2020 (n = 114,018); sampling weights used (Appendix E)
Notes: Same individual-level predictors and controls as full baseline model (Model 4 in Table 3).
Statistical significance: $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$ *(two-tailed).*

Chapter 5: Conclusion

Cultural authority is a powerful asset for any institution. Institutions with significant levels of cultural authority, by definition, tend to enjoy more public trust and influence policy debates—which often translate into specific policy outcomes. For example, research has shown that trust in science predicts mass beliefs regarding global climate change, nanotechnology, and stem cell research (Bickerstaff et al. 2008; Critchley 2008); as well as compliance with scientific guidelines regarding Covid-19 (Plohl and Musil 2020). On the other hand, mistrust in modern science is linked to the spread of many anti-science groups, including those opposing vaccines or denying the science of climate change (Alumkal 2017; Otto 2016). Thus, whether and to what extent science enjoys social prestige in a particular society are highly consequential issues. Classical modernization theorists such as Max Weber argued that modern societies were partly distinguished by their preference for rationalization: i.e., public policies would be designed based on evidence and logic, rather than by traditions or religious teachings. Ironically, the success of scientists in shaping highly salient policy debates (e.g., environmental regulations) have generated a backlash among other powerful forces and groups, who see their interests threatened by the rise of regulatory science and other manifestations of science's growing influence (Mooney 2006; Otto 2016).

Accordingly, over the past few decades, the social scientific (largely sociological) literature on the link between religiosity, membership in religious groups, and beliefs about the cultural authority of science has grown significantly. This literature often focuses on the U.S. case, documenting the politicization of science among ideological conservatives, Republicans, and/or fundamentalist groups (Alumkal 2017; Dunlap and Jacques 2013; Evans 2013; Jacques et al. 2008; Lee 2021; Mann and Schleifer 2020; Gauchat 2012, 2015; Sherkat 2017). Cross-national research in this literature has shown that religiosity is on average associated with less favorable beliefs about science or its effects on society (Evans 2014; Price and Peterson 2016), but that there is significant variation in these beliefs (Chan 2018; McPhetres et al. 2020).

Following the work of Chan (2018), McPhetres et al. (2020), this dissertation project contributes to the literature by demonstrating that the relationship between religious identity and beliefs about the trustworthiness of science is highly nuanced. In particular, it can vary significantly across societies and within them. To conclude, I briefly summarize the key findings of each paper and why they are important contributions to the literature.

Paper 1

In Paper 1, I developed a new religio-political framework for studying the cultural authority of science in the U.S.; this framework is based on the idea that public trust in science has been politicized by both religious groups and political parties. As such, there are theoretical and historical reasons to believe that beliefs about the trustworthiness of scientific institutions and findings vary within major religious groups. I applied this framework to reexamine two prominent areas of research in this literature: (1) regarding group-specific trends in beliefs about the trustworthiness of the mainstream scientific community; (2) regarding specific contested scientific issues.

The results show that there is significant heterogeneity within the major religious groups. Several findings are especially noteworthy. Study 1 shows that, contrary to widely held assumptions, trust in science has not declined broadly among biblical literalists since the 1980s—but rather, only among Republican literalists. Similarly, Study 2 demonstrates that while both Democratic and Republican literalists are less likely to accept human evolution and the Big Bang, the impact of biblical literalism is substantially greater among Republicans. Moreover, Democratic literalists are actually similar to secular independents (reference group) on the funding of human embryonic stem cell research (HESCR), whereas Republican literalists are 51 percentage points less likely to support it.

Existing studies in the U.S. have tended to focus primarily on the link between political identity and trust in science (e.g., Gauchat 2012; Mann and Schleifer 2020); or primarily on the link between religious identity and trust in science (e.g., Ecklund and Scheitle 2017; Evans 2013, 2018). Thus, Paper 1 contributes to the literature by developing and testing a single unified religio-political framework that advances our understanding of the link between party membership, religious identity, and trust in science (jointly). Ultimately, the results suggest a need to revise some influential assumptions in these debates: namely, the idea that group-specific trends or patterns (e.g., among Protestant literalists or Catholics) are broadly applicable to group members. There are also practical implications of this work: it suggests that even among Protestant literalists, regularly receiving pro-science messaging from a trusted source (e.g., Democratic Party elites, for Democrats) may reduce the probability of holding more extreme views. The lack of trust in scientific research (or the scientific community) is a social problem insofar as it can impose high costs on society, a fact that is particularly salient during the context of an ongoing pandemic like Covid-19 (Plohl and Musil 2020).

Paper 2

In Paper 2, I use an approach that combines resampling methods and unsupervised machine learning (hierarchical clustering) to measure cross-national variations in religiosity and science attitudes. There are a few papers that have used similar methods (i.e., latent class analysis) in the U.S. context, finding that a significant proportion of U.S. adults have favorable attitudes toward both religion and science (DiMaggio et al. 2018; O'Brien and Noy 2015). These papers are important contributions to the literature, because they provide empirical support for the argument that many people in modern societies do not believe that religion and science are necessarily in conflict (e.g., based on either the independence or compatibility theses; see Evans 2018).

My study extends this work in a few key ways. First, I show that there are significant numbers of people with both high levels of religiosity and favorable attitudes toward science in countries outside of the U.S. as well. In fact, this post-secular group is particularly large in Sub-Saharan Africa, the Middle East and North Africa (MENA), South Asia, and Southeast Asia. Conversely, it constitutes a small fraction of the population in East Asia. Moreover, explicitly measuring the distribution of religio-scientific classes at the country/territory level allows us to test modernization theories in new ways (e.g., Giddens 1990; Gorski and Altınordu 2008). That is, we can assess whether the prevalence of a particular class (e.g., modernist, postmodernist) varies as a function of economic security – at both the individual level and national/territory level.

Second, the results also demonstrate that there is a high degree of heterogeneity in religio-scientific perspectives even *within* countries/territories. That is, even in countries/territories where religious people have generally favorable (or less favorable) attitudes toward science, there are groups within the countries with somewhat similar (e.g., traditionalists and post-secularists) and starkly different perspectives (e.g., e.g., traditionalists and modernists). This has implications for our understanding of what kinds of political coalitions may form when science and religion compete with one another for influence and power in the public sphere (Alumkal 2017; Baker et al. 2020; Mooney 2006; Otto 2016).

Paper 3

In Paper 3, I assessed the extent to which general science attitudes, religiosity, and religious exclusivism shape people's views about conflicts between religion and science—and which side they would support given such a conflict. Overall, the results showed that general science attitudes have a relatively weak predictive effect on the outcome, whereas the predictive effects of religiosity and exclusivism are significantly greater. These differences were also largely consistent in models that assessed relationships within countries/territories and by major religious groups. These results contribute to the literature in a number of ways.

First, there are implications for modernization theory (MT). Classical forms of MT posit that the expansion of access to education and the rise of scientific/technological advances would lead to a growth in the cultural authority of science. According to this view, science would gradually replace religion and other traditional forces as the basis for legitimizing how societies are run. Yet the small predictive effects of general science attitudes (even in wealthy democracies) suggest that more favorable attitudes toward science do not directly translate into more robust support for the cultural authority of science—when that authority is contested. Future research could assess the reasons for this finding in greater depth.

In addition, religious exclusivism on average has a significantly stronger predictive effect than religiosity. That is, while trust in religion over science is associated with both dogmatic intellectual commitments (Brandt and Reyna 2010; Ludeke et al. 2013) and a desire to be loyal to one's group (Burke and Stets 2009), there is some evidence that the former matters more. Research in the U.S. has shown that fundamentalism is a stronger predictor of science orientations (e.g., interest in science, trust in science) than religiosity. The present study extends these findings by showing that they are generalizable beyond the U.S. context—in various regions of the world, opposition to the cultural authority of science is more a product of having particularly conservative religious orientations rather than being religious per se.

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