

# The Economics of Faith: Using an Apocalyptic Prophecy to Elicit Religious Beliefs in the Field\*

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## Abstract

We model religious faith as a “demand for beliefs,” following the logic of the Pascalian wager. We show how standard experimental interventions linking financial consequences to falsifiable religious statements can elicit and characterize beliefs. We implemented this approach with members of a group that expected the “End of the World” to occur on May 21, 2011 by varying monetary prizes payable before and after May 21st. To our knowledge, this is the first incentivized elicitation of religious beliefs ever conducted. The results suggest the existence of a demand for extreme, sincere beliefs that was unresponsive to experimental manipulations in price.

**JEL codes:** *D84, D81, Z12, N30*

**Keywords:** *economics of faith, religion, faith, time preference, beliefs, field experiments*

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# 1 Introduction

Classic authors like Durkheim (1915) credit religion with shaping social relations since the origin of civilization, and historians emphasize the role of religion undergirding power structures before modern institutions such as markets, firms, or government came into existence (Finer 1997). In present times, large shares of the population worldwide continue to report religion to be a vital element of everyday life.<sup>1</sup> Religion has been linked to growth and development (Barro and McCleary 2003; Kuran 1997), policy preferences (Scheve and Stasavage 2006), (Huber and Stanig 2011), and a variety of different behaviors and life outcomes.<sup>2</sup> Consequently, economists have developed a field to understand the “production” of religion and the substantial material activity associated with it. This field has focused much attention on the supply side of the market for religion, such as the industrial organization of religious activity. Iannaccone (1998) surveys that literature and argues that the demand side, linked to the nature of religious beliefs, has received less attention. This paper investigates what is presumably a key driver of the demand side of religion, namely faith (i.e., religious beliefs), through a simple model and a field experiment.

Studying faith poses conceptual and empirical challenges. A microfoundation for demand usually posits a utility function and beliefs that are driven by information. While faith involves beliefs, it has long been associated (even by famous believers such as Pascal (1668) and James (1909)) with a *will to believe*, suggesting a non-standard connection between utility and beliefs.<sup>3</sup> On the empirical side, there are challenges to measuring faith. Authors have noted the potential for individuals to misrepresent their beliefs when asked about religion.<sup>4</sup> An alternative to measuring beliefs is to track religious participation. But this approach cannot elucidate the role of faith in the demand for religion, as religious participation may also reflect material returns. These difficulties suggest the use of incentivized elicitation methods, which work by having subjects make predictions that are rewarded based on accuracy. The problem with predicted religious events is that they are typically unobservable (e.g., God’s

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<sup>1</sup>In the case of the United States, a 2008 Gallup poll showed that 65% of respondents consider religion to be important in their everyday life. In 2011 Gallup reported that over 90% of Americans believe in God, and 73% believe with absolute certainty.

<sup>2</sup>See Iannaccone (1998) for an excellent review of this evidence. There is also a body of empirical evidence on religion from laboratory experiments; see Hoffman (2012) for a review. More recently, it has been shown that religiously motivated activities can shape social attitudes, such as tolerance (Clingingsmith, Khwaja, and Kremer 2009), but also negatively affect societal outcomes such as innovation (?).

<sup>3</sup>The dictionary definition of faith separates it from evidence in the statistical or logical sense. According to the Oxford dictionary, faith is “a strong belief in God or in the doctrines of a religion, based on spiritual apprehension rather than proof.” See Montgomery (1996) for a discussion of some of the challenges to an economics approach to faith.

<sup>4</sup>Kuran (1995) elaborates on the fact that tendencies to conform may lead to a falsification of preferences and beliefs. See Krosnick and Presser (2009) p. 285 on survey response bias more generally.

existence). Despite the long history of religion in human affairs, to our knowledge religious beliefs have never been measured scientifically in an incentivized manner.

In this paper we make three contributions. The first is an approach to bring incentives into the measurement of the level and elasticity of religious beliefs. The key requirement is to locate religious propositions that are (presumably) believed in, and are also falsifiable. Then we can rely on belief elicitation techniques that reward predictions based on their accuracy. The second is the concrete findings of our approach when implemented with a specific religious group, to be described shortly. The third is a formal theory of religious beliefs that explicitly models the experimental intervention and offers a faith-rooted microfoundation for the demand side of religion. The theory and the experimental context favor interpreting our findings as supporting the idea that a will to believe, or a “demand for beliefs,” play a role in religiosity.

We administered an experiment to implement our elicitation approach, relying on the well publicized prophecy made by Harold Camping, an elderly Christian radio talk show host, who held that May 21st, 2011 would be the “End of the World.” On May 21st, the prophecy went, the biblical Rapture would occur: divine judgement would be passed and the “saved” would ascend to Heaven to meet God, while great cataclysms would ravage the Earth. The “non-saved” would suffer “Hell on Earth” for five months, until all of creation would be annihilated on October 21st, 2011. Camping’s prediction attracted a world-wide following, driven by tens of millions of advertising dollars and daily discussion on his Family Radio network, one of the largest Christian broadcasting networks in the U.S.

In our experiment we elicited beliefs in the End of the World prophecy by having subjects make time-preference decisions in the weeks prior to May 21st. We exploited a key aspect of the beliefs espoused by Family Radio followers, namely that money would have no value after May 21st, both if one was raptured to Heaven or was left to suffer Hell on Earth. Thus, Family Radio followers should discount money payable after May 21st to reflect their belief that the prophecy would come to pass, in addition to a pure time preference.<sup>5</sup> In order to approximate a control group we also approached members of the Seventh Day Adventist Church (henceforth, SDA), who are theologically similar to the Family Radio members but, crucially for our study, did not consider May 21st a special date.<sup>6</sup> We offered both the Family

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<sup>5</sup>In fact, there were numerous media reports about believers in the prophecy making material decisions in anticipation of the events of May 21st, such as spending down bank accounts or winding down businesses. Several subjects told us they were making similar decisions; in a survey implemented *a posteriori* of the experimental interaction 68% of them reported higher spending as a direct result of their beliefs, with the majority reporting increased spending on donations.

<sup>6</sup>Seventh Day Adventists are a large Christian denomination (16.3 million members worldwide, and the 7th largest denomination in United States) who believe that Jesus Christ’s return to Earth is “imminent,” yet accept that “no man shall know” (*Matthew 24:36*) the exact date. Seventh Day Adventist member

Radio and the SDA subjects a choice between \$5 “today” (that is, before May 21st), and a variety of amounts up to \$500 four weeks in the future (after May 21st), using a Becker-DeGroot-Marschak method (Becker, DeGroot, and Marschak (1964), henceforth, BDM) to capture the exact amount payable after May 21st that would make the subject indifferent with \$5 today. For the SDA group, we expected a discount rate that exclusively reflects a pure time preference. If beliefs in the prophecy among Family Radio members are a matter of external profession rather than inner conviction, we would expect their choices to resemble those in the SDA group. If their beliefs were sincere, we would expect their revealed discount rates to be higher.

The evidence indicates that the vast majority of Family Radio members held extreme beliefs even in the face of direct financial costs—nearly all Family Radio subjects preferred \$5 dollars today to any amount up to \$500 payable after the Rapture. In contrast, the SDA members made choices consistent with time preference parameters estimated in laboratory studies (Frederick, Loewenstein, and O’Donoghue 2002). Taken together, these findings indicate that the Family Radio members held sincere and full beliefs in the prophecy. These beliefs matched the ones they reported in a survey after the experiment. To our knowledge, this initial set of findings provides the first experimental documentation of the role played by sincere faith in the demand for religion.<sup>7</sup>

The remainder of our empirical results is best discussed in the context of our theory. In our analysis we remain committed to an economics approach in that we abstract from religious notions such as beliefs driven by revelation or grace. A literature in economics has explored the manipulation of beliefs (see inter alia Akerlof and Dickens (1982), Bénabou and Tirole (2004), Brunnermeier and Parker (2005), Köszegi (2006)), so we follow this approach and conceptualize faith as a willful choice of beliefs. However, we replace the psychological drivers in those theories (cognitive dissonance or anticipatory utility—which we can also incorporate in our model) with what is probably the best known argument for a rational choice of religious belief, namely Pascal’s wager (Pascal 1668). Pascal offered a clear decision-theoretic argument for beliefs as insurance: in the case that God exists, belief in him will be greatly rewarded; in the case that God does not exist, belief in him will not hurt, so it is optimal to believe.<sup>8</sup> We refine Pascal’s logic by clearly separating actions from beliefs and

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statistics are available at [www.adventist.org/world-church/facts-and-figures/index.html](http://www.adventist.org/world-church/facts-and-figures/index.html).

<sup>7</sup>It may be argued of course that sincerity can only be established in relation to the stakes offered in the experiment. Perhaps \$10,000 would induce different behavior than \$500. But in other realms where survey bias is also suspected—e.g., politics—the introduction of moderate stakes sharply alters response patterns relative to unincentivized surveys ((Bullock and Huber 2013)). Thus, we believe it is noteworthy that our elicitation of religious beliefs under conditions of privacy and under reasonably sized stakes replicated the survey-based response patterns.

<sup>8</sup>As it turns out, Pascal offered three arguments, not one, anticipating possible objections. To the most

integrating the logic of the wager into a choice problem with well defined costs and benefits. This allows us to define the notion of a demand for religious beliefs as the holding of beliefs that stem from choice, not information. The model makes it clear that when beliefs are held over states of the world that are observable, rewards for accurate predictions are possible, and beliefs can be elicited.

In the model, agents have different prior beliefs on the realization of a state of nature that is religiously relevant (e.g., God exists, the Rapture will happen), and can choose what beliefs to hold as well as take other actions which yield state-dependent payoffs.<sup>9</sup> The benefit of manipulating beliefs is that, under a doctrine of salvation through belief, agents receive a higher spiritual payoff if the religious state is realized. The cost of this manipulation is that the agent's actions are distorted if the religious state is not realized. The model predicts the existence of a marginal individual, in terms of initial priors, who separates believers from skeptics. Believers concentrate their posteriors on a full religious belief while skeptics retain their priors. One takeaway from the model is that a rational choice of faith can lead individuals with similar priors to separate into extreme believers and skeptics.

As in other models with belief choice, agents in our model make a decision on what beliefs to hold, and then take those beliefs seriously when selecting actions, much as if they had forgotten the choice-based origin of those beliefs. An intriguing question is whether unexpected, financially relevant, decisions may invite some examination and reoptimization of those beliefs. If this is the case, an experimental condition that raises the cost of religious beliefs should go together with a smaller number of full believers. However, if subjects truly “forget” their original prior and can only reoptimize using their chosen (full) belief, beliefs will be price-inelastic and the number of full believers will remain constant. In our experiment we varied the probability of implementation of the BDM lottery to affect the cost of beliefs, and found no evidence of beliefs being price-sensitive. Following the theory, this can be interpreted as evidence that, when facing unexpected financial decisions, subjects reoptimize beliefs on the basis of chosen beliefs. We must note that the inelasticity of beliefs could also be observed if beliefs are sticky in the short run, in which case some elasticity may be detected only when incentives are varied persistently.

Caveats must also be noted when interpreting our initial results: we view the difference

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well-known dominance argument, he added two expected value arguments which allow mistaken beliefs to carry a penalty (Hacking 1972). In order to justify belief by those who are strongly skeptical Pascal invoked infinite payoffs from Heaven.

<sup>9</sup>Following much of the economics literature on belief manipulation, we abstract from the process by which beliefs are chosen. It is often hypothesized that individuals may select sources of information in a way that introduces bias and then omit to correct for that bias when processing their information. Pascal himself considered that the choice of beliefs may follow a less than instantaneous process that relies on self-selecting into religious practices and environments.

in the choices made by Family Radio and SDA subjects as reflecting a will to believe. The main threat to this interpretation is that beliefs could arise independently of a willful choice. For instance, beliefs may have been inculcated in early age or impressed upon by a respected authority; alternatively, beliefs may reflect pathology or come from a religious revelation. While understanding the complex origins of religious beliefs is inherently difficult, we believe that our specific environment alleviates some of these concerns as (i) the prophecy constituted a new prediction, so beliefs in it could not have been inculcated in early age; (ii) the prophecy was disputed by most Christian authorities, and its associated group displayed relatively low social cohesion, making authority and peer effects less likely drivers; (iii) as we discuss in our next section, scholars researching apocalyptic ideas have long emphasized that beliefs in such prophecies are common in history and unrelated to pathology; and (iv) no revelation was adduced as evidence.

Reports are common of people making material sacrifices for the sake of their religiosity, so it may be argued that experiments are unnecessary because those acts must already reflect sincere beliefs. But it is important to rule out actions that may be taken for instrumental reasons, such as signaling conformity to attain social, economic, or political goals. What is unique to our approach is that we implemented a mechanism for the truthful revelation of religious beliefs with two key features: the choices made in the experiment were private, and the ensuing financial consequences were controlled by the experimenters rather than a matter of anecdotal reports by third parties or by the putative believers.

In addition to the previously noted connections between our paper and the literature on the market for religion and belief manipulation, our paper complements the literature that utilizes survey data, such as that in the World Values Survey, to address the interplay between economics and religiosity (see for instance Barro and McCleary (2006) and Huber (2005)). Our approach highlights the possibility of studying religious beliefs in an incentivized experimental setting. This addition to the toolkit of religion researchers could supplement observational data and unincentivized survey instruments.

The plan for the paper is as follows. The next section offers background on Family Radio and the historical context of apocalyptic ideas. Section 3 presents the model, Section 4 presents the experiment and results, and we reserve further discussion of related literature for Section 5, as it will prove more fruitful to discuss it after we have established our results. Section 6 concludes.

## 2 Background

### 2.1 Family Radio and Camping’s May 21st 2011 prophecy

Family Radio (henceforth FR) is a Christian talk and music radio broadcasting network with 164 stations and relays in the United States as of May 2011.<sup>10</sup> In 2007, FR was the 17th largest owner of radio stations in the United States in terms of number of stations and had assets well above the hundred million dollar mark.<sup>11</sup> For nearly fifty years FR has broadcast a program on weekdays called “Open Forum,” in which the station’s co-founder and president, Harold Camping, answers listeners’ questions about the Bible.

In early 2005, Camping published a book called *Time Has an End: A History of the World 11,013 B.C. to 2011 A.D.* (Camping 2005), which contained purported biblical proofs that the Rapture—an event in which a selected few are transported directly to Heaven—would occur on May 21, 2011. On this date, Camping predicted that “great earthquakes will occur” and those not raptured “will exist [for 5 months] in a world of horror and chaos beyond description” until October 21, 2011, when “God will completely destroy this creation and all of the people.” An important aspect of Camping’s prophecy is that money would have no value after the Rapture, neither for the saved or the damned. This aspect was emphasized repeatedly by Family Radio members in their interactions with us.

Camping’s evidence for this prediction largely relies on biblical exegesis and numerology. For example, based upon verses in the Old Testament, Camping believed that the biblical flood involving Noah occurred in 4990 BC of the Roman calendar. Then, taking a statement in *Genesis 7:4* (“Seven days from now I will send rain on the earth”) as a prediction about the end of the world combined with a statement in *Second Peter 3:8* (“A thousand years are like a day”), Camping concluded that the end of the world would occur in 2011, some 7000 years after the flood. Camping used other Bible passages to narrow down his prediction that Judgement Day would occur exactly 722,500 days from the date of Christ’s crucifixion (April 1, 33), leading to the May 21, 2011 date. Camping repeatedly stated that there is “no longer any question” about this date, and that “the Biblical evidence is too overwhelming and specific to be wrong.”<sup>12</sup> This certainty required resolving contradictions with scriptural discouragements to engage in apocalyptic date-setting (most notably the statement in *Matthew 24:36* that “no man shall know” the exact date) and interpreting many

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<sup>10</sup>More information can be found at <http://fsiforms.familyradio.org/stations/search.php>

<sup>11</sup>This information as well as data on expenditures we refer to later is available through IRS 990 forms that all charities are required to publicly disclose.

<sup>12</sup>In 1992, Camping wrote *1994?*, a book in which he promoted September 6, 1994 as a potential date for the Rapture; he did not express certainty in this book. However, according to Family Radio literature, “important subsequent biblical information was not yet known, so this book was incomplete.”

ambiguous passages as metaphorically referring to the end of times, in a way that creates room for willful choice playing a role. Faced with the same arguments, many other Christians who share the apocalyptic frame of mind, such as SDA members, gave more weight to alternate interpretations.

In addition to the radio program, FR promoted the Judgement Day prediction by spending tens of millions of dollars to place 2000 billboards in over 40 countries and sending multiple R.V. caravans across North America. Camping also held weekly Bible studies at the Alameda Veteran’s Memorial Hall, near the station’s headquarters in Oakland, CA. By May of 2011, the story of Camping’s prediction and his numerous followers was covered by many prominent news outlets, including Time Magazine, New York Times, Washington Post, Los Angeles Times, AP, and Reuters. Many of these reports mentioned that followers were engaging in various behaviors consistent with “end of the world” beliefs, such as spending down bank accounts and winding down businesses. A survey conducted with FR members confirmed this pattern. Still, these declarations to reporters and surveys could be biased, motivating the need for a private and incentivized elicitation of beliefs.

## **2.2 Are May 21 believers exceptional?**

To some observers, definite beliefs about the end of the world appear so unwarranted that they must reflect an unsound mind and therefore cannot reveal anything general about how humans form beliefs. Our personal interactions with FR members yielded an impression of overall normalcy. But perhaps more importantly, the experts on apocalyptic movements highlight the links between apocalypticism and mainstream religion, and emphasize a distinction between apocalypticism and pathology.

Apocalyptic ideas arose with the attempts of the first civilized groups to explain reality through myth-making and religion. In fact, according to (Wagar (1982), p. 36), “Cultures without terminal visions of some kind have in all probability never existed.” Interestingly, apocalyptic myths follow a similar pattern across cultures from the Judeo-Christian-Islamic tradition to Persian Zoroastrianism, Hinduism, and Babylonian, Roman, and Greek traditions (Eliade 1954; Wagar 1982). A recurring theme involves the current world ending by a divine intervention that unleashes great catastrophes (floods, fire, earthquakes), and which punishes the sinful and rewards the virtuous.<sup>13</sup>

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<sup>13</sup>A particularly powerful and recurring narrative involves the biblical flood as an instance of divine judgment and punishment. The story of Noah’s Ark is believed by many mainstream Christians, Jews and Muslims, and accepted as a fairly uncontroversial part of the Bible (Genesis 6–9) and Quran (surahs Hud and Al-Mu-minoon). Many Family Radio billboards used the phrase “Noah Knew,” alluding to the idea that to “hear the call of God” provides salvation from disaster.



The Christian apocalyptic ideas derive from the Jewish eschatology (a part of theology concerning the end of time), and they augment the idea of a Judgement Day with a physical second coming of Christ that will eliminate sinners, save the just, and usher in the Millennium. Scholars of modern apocalyptic movements emphasize the deep Christian apocalyptic tradition; according to McGinn (1998), “Apocalyptic is the mother of all Christian theology.” In this vein, these scholars argue against the stance that modern apocalyptic belief reflects pathology. In *Waiting for the Apocalypse* Daniel Cohen writes:

The modern catastrophist often relies on dubious theories, mistranslations, or simply misinterprets the evidence to suit his own beliefs. It would be a mistake, however, to put down the modern catastrophist as a fraud, a fool or a madman. Usually he is honest, intelligent, and quite sane—he is simply devoted to an incorrect idea [...] driven by the desire to prove that the Bible or parts of it are literally true, though he may not easily acknowledge or even understand the emotional basis of his beliefs. (Cohen (1983), p. 72)

Along similar lines, Kyle writes that the members of the Millerite movement—perhaps the quintessential American apocalyptic group whose members expected Judgement Day to occur in 1843—were “quite sober and unmarked by fanaticism” even though they were reported to be willing to make very costly financial decisions when approaching the crucial dates of the prophecy (Kyle (1998), p. 90). Following the failed prediction, the Millerite movement spawned different mass religious groups with membership in the millions in the United States, all holding apocalyptic beliefs today, including the Seventh-Day Adventists and Jehovah’s Witnesses (this is in addition to the large Mormon congregation, which arose independently in the same generation and shares the apocalyptic tenets). The Jehovah’s Witnesses have believed in a series of Judgement Day dates since 1843, while as we stated earlier, the SDA Church evolved as a branch that rejects date-setting.

The observations above suggest two main ideas. First, apocalyptic themes do not seem to be a reflection of pathology. Rather, they are deeply lodged in the symbolic and narrative structures with which large parts of the world population have come to organize their sense of justice and history. Within that uniformity, we find groups of people who, given the same information, are willing to engage in date-setting while others are not. A key element appears to be the discretionary way in which scriptural ambiguities and contradictions are resolved. This in turn indicates that apocalyptic belief is more a matter of *choice* than of Bayesian necessity. Second, the FR movement is not unique, but rather another link in a long chain of like movements. As our theory will indicate, the mechanism through which a will to believe can shape apocalyptic beliefs can similarly shape religious beliefs more generally.

### 3 Experimental Design

We designed an experiment with two goals. One was to elicit beliefs in Harold Camping’s Judgement Day prophecy that the “End of the World” would occur on May 21st, 2011. The other was to study the elasticity of those beliefs given changes in the costs of holding them.

To elicit beliefs, we used the well known BDM method (Becker, DeGroot, and Marschak 1964) to elicit the indifference point between a \$5 present-dated check and some amount of money payable by a post-dated check in four weeks (a date intentionally set post-May 21). To understand the intuition behind the design, recall that Camping’s prophecy implies that money would be useless after the Rapture. Therefore, money payable after May 21st would only hold value in the non-religious state in which the Rapture did not occur. A person with a higher belief in the prophecy would require a higher payment after May 21st to maintain indifference with \$5 payable today. For example, a risk-neutral person with no pure time preference and a 50% belief in the prophecy would require \$10 after May 21 to be indifferent with \$5 payable before May 21st, while a person assigning an 80% probability to the prophecy being true would instead require \$25 after May 21.

Before discussing the elicitation of the elasticity of the belief, it is useful to discuss how beliefs might change with their “price.” In traditional economics, beliefs do not respond to prices because beliefs are formed mechanically through Bayes rule given a prior and objective signals about the environment. As we discuss formally in the model presented in Section 4, our experiment is premised on the idea that people can choose beliefs to balance costs and benefits. A person might choose to believe in the Rapture because this is thought to earn salvation. However, this belief will cause other decisions to be distorted relative to what the prior belief would warrant, which creates a cost in terms of materially driven expected utility. For example, the person may overinvest in efforts to spread the word about May 21st, and make financial decisions in the experiment (as well as outside) as if there were no future. One can imagine that if the cost in terms of suboptimal material decisions becomes more likely, more individuals may decide to forgo the full belief.

In order to experimentally vary the cost of suboptimal beliefs, we randomly assigned participants to two treatment conditions which corresponded to different probabilities that the participant’s payment would be tied to his decision in the BDM scheme. Specifically, participants were informed that their decision elicited by the BDM method would be implemented with either a 6% or a 50% probability: these probabilities were chosen in order to maximize the range of expected future payments while staying within our experimental budget. This variation defined the two treatment *conditions* in our experiment. Note that the cost of a distorted belief to a participant varied with the implementation probability,

allowing us to test the null hypothesis of a zero price elasticity of beliefs.

The experiment was run with two distinct subject *groups*: FR members and SDA members, which yields a 2x2 *group-condition* matrix. As discussed above, SDA members hold beliefs similar to those of FR members concerning the existence of the Judgement Day and the Rapture, except that SDA members do not claim to know the precise date.

Importantly, the FR and SDA samples should not be interpreted as treatment versus control subjects since membership is obviously endogenous. The reason we use the SDA sample is to see whether people who hold a belief system that is almost identical to that of the Camping followers, apart from the specific date prediction, tend to have what we think would be normal money-time preferences. If this is the case, it would alleviate concerns that results for the FR members are driven by an inability of subjects to understand the experimental decision, or due to a lack of trust in us as experimenters to deliver on promised future payments.

At this point it is worth making two methodological points. First, in eliciting beliefs, one might prefer to use a method that is robust to risk aversion, such as that by Karni (2009). Unfortunately, using such a method is not possible in our situation as it would require making immediate payments contingent on states that are unobservable (e.g., the Rapture taking place) at the time of payment. However, as we will discuss later, the presence of any reasonable level of risk aversion would not significantly affect our quantitative conclusions. Second, one might consider a potentially more natural experimental design in which we vary the experimental payments, rather than the probability of implementation, across the two conditions. This design poses additional problems if individuals are risk averse: payment manipulations can induce changes in declared cutoffs that reflect changes in the curvature of the utility function, rather than changes in underlying beliefs. As we demonstrate in the theory section, we avoid this confound when manipulating the probability of implementation.

### 3.1 Subject recruitment

FR volunteers were solicited from outside a Bible study led by Harold Camping in a public hall in Alameda, California, on two consecutive Sundays, May 8th and 15th, 2011. SDA volunteers were solicited from the congregation of an SDA church in San Francisco, California, on Saturday, May 14th, 2011 (SDA services are on Saturdays). We estimate that both the Family Radio Bible study meetings and the SDA service were attended by about 100 adults each.<sup>14</sup>

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<sup>14</sup>We chose to administer the survey to the San Francisco SDA congregation because they were the nearest SDA Church to the Family Radio Bible study that responded to our request to survey its members after a service.

For both groups, we set up a table outside the building where each group met, and upon exit we asked people if they would like to participate in a survey concerning their beliefs. Potential participants were informed that they would receive five dollars cash for participating, that after the initial part of the survey they would get to make decisions that could generate further earnings, then answer a final questionnaire, and that we would donate three dollars to their organization for each completed survey.<sup>15</sup> About half of the potential subjects we talked with declined to participate after reading the consent form.

It is likely that our recruitment method induced some selection with both groups. First, we likely faced the standard experimental selection problem: the higher a person's valuation of time, the less likely participation is. Second, some members from both groups told us they thought participating seemed too much like gambling, or was a form of work which, according to their beliefs, should not be done on the Sabbath (Sunday for FR members and Saturday for SDA members). Those who refused to participate on these grounds are likely to be stricter Christians than those that did participate, so selection seems to be against hardcore members of the groups.

### **3.2 Participant instructions**

Upon obtaining written consent, participants within each sample were randomly assigned to one of two treatment conditions and given the appropriate decision packet.<sup>16</sup> They were informed that their answers would not be made public, nor would we collect personally identifiable information. Furthermore, every effort was made to ensure that participants did not talk among themselves and that they made all decisions privately.

Subjects answered (privately) two sets of questions, one before and one after the decision-making segment of the experiment. The first set asked participants general questions about faith and whether/how the participant had heard about the prediction that May 21st, 2011 would be the Judgement Day. The aim of these questions was twofold. First, we thought beginning with a respectfully worded questionnaire focusing on faith would make subjects feel more comfortable and facilitate a transition to the decision-making part of the study. Second, we wanted to even out perceptions across both FR and SDA groups regarding the potential nature of the study. The second set of questions, presented after the experiment, concerned more directly beliefs on Judgement Day, decisions subjects may have made based on this belief, and how they thought they would adjust their beliefs if May 21st passed uneventfully. These more specific questions were asked after the decision-making part of the

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<sup>15</sup>The donation to the organization helped us garner approval from the organizers of each group.

<sup>16</sup>Decision packets for the 50% treatment from both groups are included in the online appendix at [faculty.nps.edu/jcunha/research/faith\\_appendix.html](http://faculty.nps.edu/jcunha/research/faith_appendix.html); the 6% packet is identical up to the stated probability.

study to avoid decision-making distortions stemming from a taste for consistency between any specific answers given previously and incentivized behavior.

The packet informed participants that the decision-making part of the survey was to proceed in three stages. First, they would be asked to make a decision between receiving \$5 dollars today and different amounts of money in four weeks, and that this decision would only be implemented with a particular probability (6% or 50% as indicated by their treatment condition). Second, the researchers would flip a coin or coins (one coin for the 50% probability condition or four coins for the 6% probability condition) to determine if their decision in the first stage would be played. Finally, if the coin(s) came up heads, the researchers would determine the actual payoff through the lottery described below. Depending on the participant’s first stage decision, the subject was either written a present-dated check for five dollars or a four-week-post-dated check for the payoff amount.<sup>17</sup> This payment by check was in addition to the 5 dollars paid in cash for participation. Payments took place in a removed station. No visible differences in the form or procedure of payment took place across subjects depending on their decisions.

We explained the BDM method in a simple fashion. Participants were presented with a picture of 50 circles—representing 50 small balls in bag—with a dollar amount associated with each circle/ball ranging from \$1 to \$500.<sup>18,19</sup> The picture expressed exactly the distribution of amounts in play. Figure 1 contains the diagram that was included in the packet for the 6% condition.

We instructed subjects to circle all of the amounts they would prefer to have in four weeks as opposed to \$5 today. We refer to the smallest amount circled as the “cutoff” amount. If they preferred \$5 today instead of any of the amounts in four weeks, they were instructed to circle a box stating “I prefer \$5 today.” Subjects were also told that a ball would be drawn, and that if the ball drawn showed an amount lower than the cutoff they would be paid \$5 that very day, and that if the ball showed an amount larger or equal than the cutoff then they would be paid the amount shown by the ball in four weeks. As expected, some subjects did not immediately understand the BDM method and were consequently helped by one of the researchers. In these cases, we asked participants to imagine a ball with a particular amount was selected and decide if they would rather “receive that amount in 4 weeks or

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<sup>17</sup>In addition to postdating the check and including the memo “Do not cash this check until [4 weeks hence],” we instructed the bank to temporarily put a stop on the checks for four weeks, and informed participants this had been done.

<sup>18</sup>Our initial setup had the 50 balls in a bingo cage. In the early stages of the experiment, it became clear that some group members associated the bingo cage with gambling, an activity that both groups steadfastly oppose. Therefore, we switched to placing the balls in a bag.

<sup>19</sup>Amounts less than \$5 were included as a test to make sure participants understood the BDM method. As we show below, no participant chose an amount less than or equal to \$5.

## Your Decision

Now, it is time to fill out your answer below.

Again, feel free to ask a researcher if you are confused or have ANY questions.

**Reminder: This decision will only count for real money if you make it to Stage 3. This will happen if the coin lands HEADS four times in a row in Stage 2 (which has a 6% chance of happening).**

1	3	5	6	7	8	9	10	11	12
14	16	18	20	22	24	26	28	30	32
34	36	38	40	43	46	49	50	60	70
80	90	100	100	100	100	100	110	120	130
140	150	160	170	180	190	200	200	200	500

In 4 weeks

I prefer \$5 today.

**Once you have circled your choices, please approach a researcher so we can flip the coin for you.**

Figure 1: Example of the decision page of the questionnaire from the 6% condition. This page was the same for both the Family Radio and SDA subject pools.

receive \$5 today.”<sup>20</sup> In a few cases where the subject did not circle any amounts, we checked and confirmed that they had a cutoff of at least \$500. Conditional on choosing a \$5 cutoff and having the random ball draw implemented, the expected value of playing the game was \$79.

### 3.3 Participant Overview

We surveyed 27 FR members and 29 SDA members. Of the 27 FR members, four were excluded before we analyzed the data. We excluded a mother and daughter pair, as we observed

<sup>20</sup>One may worry that in offering help the researchers broke subject privacy. However, most subjects needed no help, and as we will see the results are strikingly uniform across subjects regardless of whether they needed help or not.

the mother break protocol and approach the daughter to discuss the experiment; we excluded two other subjects because they were merely observers, not Family Radio members.<sup>21</sup> Thus, our analytical sample contains 23 FR and 29 SDA subjects.

## 4 Theory

In the previous section, we intuitively argued that our experimental design can elicit the beliefs about a specific religious statement and can identify the elasticity of beliefs through the experimental manipulation of the cost of holding such beliefs. In this section, we develop a model of a more general experimental protocol with these characteristics, demonstrate when and how it works, and connect it to our specific experimental design. If the reader is not interested in a theory of faith, and content with the intuitive explanation of our identification approach, this section can be skipped.

In the model, individuals choose their religious beliefs to maximize expected utility in a way similar to the Pascalian wager, trading off a potential spiritual payoff from holding stronger religious beliefs with the potential material costs from making suboptimal decisions as a consequence of these beliefs.<sup>22</sup> We first model individual behavior in the absence of experimental interaction, and then we explicitly model how the experiment can help characterize religious beliefs. Unless indicated otherwise, all proofs are relegated to the appendix.

### 4.1 The basic model

#### 4.1.1 Structure and payoffs

There are three periods. We discuss the periods in reverse order. In period 3, one of two states of nature is realized: the “religious” or the “non-religious” state. The religious state could be one in which God exists or in which the Rapture occurs on May 21st. If the religious state is realized, the agent receives a spiritual payoff  $U_r$ , discussed below. There is a continuum of agents characterized by their prior belief  $\pi$  that the religious state will occur. In period 2, the agent chooses an action  $a \in \mathbb{R}$ . For example, the action could be attending church or spreading the word about May 21st. Based on the action  $a$ , the player

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<sup>21</sup>It became apparent that the mother was a FR member, but did not speak English, while the daughter was not a FR member and was simply there to accompany her mother. The non-Family Radio members identified themselves to us as such after the experiment.

<sup>22</sup>In a previous version of the paper, we modeled the decision as a (similar) tradeoff between anticipatory utility from religious beliefs and material costs from suboptimal choices. As these two models lead to similar results, we stick with the current model as it is significantly more parsimonious.

receives a material expected payoff  $f(a, \pi)$ , where we assume that  $f(\cdot)$  is continuous, twice-differentiable with  $\frac{\partial^2 f(a, \pi)}{\partial a^2} < 0$ ,  $\frac{\partial^2 f(a, \pi)}{\partial a \partial \pi} > 0$ , and that  $\frac{\partial f(a, \pi)}{\partial a} = 0$  for some  $a \in \mathbb{R}$  for every  $\pi \in [0, 1]$ . These assumptions imply that  $a^*(\pi) = \arg \max_a f(a, \pi)$  is unique and strictly increasing in  $\pi$  (there is an optimal action and it increases with the belief in the religious state). The payoff  $f(a, \pi)$  is collected in period 3.

We use the function  $f(a, \pi)$  to capture various situations while minimizing notation. As an example, consider a person choosing a level of prayer intensity  $a$ . The action is costly in terms of time and effort according to the increasing, differentiable, and convex function  $c(a)$ .<sup>23</sup> The action also yields an increasing, differentiable, and concave material benefit  $b(a)$  in the form of divine reward (e.g., prayers answered) or avoided punishment that would be suffered on Earth in the absence of prayer. The benefit accrues only in the religious state; for instance, a prayer for health only works if the god that is being prayed to actually exists. In the eyes of the person, the action  $a$  induces an expected payoff  $\pi b(a) - c(a) \equiv f(a, \pi)$ . Note that imposing the standard assumptions  $c'(0) < b'(0)$  and  $\lim_{a \rightarrow \infty} c(a) > \lim_{a \rightarrow \infty} b(a)$  then guarantees that the function  $f(\cdot)$  thus obtained satisfies the assumptions made above.

In period 1, in the major deviation from standard economic models, we allow the agent to *choose* a belief  $\hat{\pi} \in [0, 1]$  in the religious state. This choice of belief has two effects on the agent's payoff. First, we require that the agent's action decision be *consistent* with the chosen belief. That is, the agent must choose the action  $a^*(\hat{\pi})$ , acting *as if*  $\hat{\pi}$  was the correct probability of the religious state, meaning the agent will maximize  $f(a, \hat{\pi})$ .<sup>24</sup> Note that, as the agent's true payoff is  $f(a^*(\hat{\pi}), \pi)$ , choosing a belief  $\hat{\pi} \neq \pi$  will lead to an action choice  $a^*(\hat{\pi}) \neq a^*(\pi)$ , and a lower payoff as  $a^*(\pi)$  is the unique maximizer of  $f(a, \pi)$ . For notational ease, we define the expected payoff penalty from choosing different beliefs as  $p(\hat{\pi}, \pi) = f(a^*(\pi), \pi) - f(a^*(\hat{\pi}), \pi)$ , where our previous assumptions imply that the implicit penalty  $p(\hat{\pi}, \pi)$  is continuous, twice-differentiable, minimized at 0 when  $\hat{\pi} = \pi$ , and on both sides of  $\pi$  the penalty attains a higher value as  $\hat{\pi}$  deviates farther from  $\pi$  ( $\frac{\partial p(\hat{\pi}, \pi)}{\partial \hat{\pi}} \leq 0$  for  $\hat{\pi} \leq \pi$ ).<sup>25</sup> Second, the belief choice affects the agent's spiritual payoff; this is the other nonstandard feature of our model in addition to belief choice. Specifically, we model the

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<sup>23</sup>In the case where  $a$  tracks participation in rituals the costs are similar. In cases where  $a$  tracks refusing certain foods or medical treatment (as when Jehovah witnesses refuse blood transfusions) the costs could take the form of forgone pleasures or health complications.

<sup>24</sup>The idea that beliefs can be chosen follows the basic logic of the Pascalian wager, as well as more recent work relating belief choice to psychological motives (e.g., Akerlof and Dickens (1982) and Brunnermeier and Parker (2005)). While the model is stark, the choice of beliefs may be interpreted not as a direct and instantaneous action but a more indirect and gradual one. We revisit this issue later when discussing the elasticity of beliefs.

<sup>25</sup>Returning to the prayer example,  $p(\hat{\pi}, \pi) = f(a^*(\pi), \pi) - f(a^*(\hat{\pi}), \pi)$  is  $\pi b(a^*(\pi)) - c(a^*(\pi)) - [\pi b(a^*(\hat{\pi})) - c(a^*(\hat{\pi}))] \geq 0$ .



spiritual payoff  $U_r$  as a function of chosen beliefs  $\hat{\pi}$ :

$$U_r(\hat{\pi}) = \begin{cases} u_r > 0 & \text{if } \hat{\pi} = 1 \\ 0 & \text{otherwise} \end{cases}$$

We make the payoff  $U_r$  discontinuous to capture simply a common feature of religion, which is to make salvation conditional on faith seen as a complete belief. The assumed discontinuity of  $U_r$  *is not necessary* for our main results, but does make the results more transparent.<sup>26</sup> The assumption of salvation through faith is central to Pascal’s arguments and, according to Durkheim, it is an empirically sound assumption when characterizing religiosity, as “The first article in every creed is the belief in salvation by faith.” (Durkheim 1915) (p. 416). This link was expressed to us by several FR members and is true of Christianity more generally. Many passages in the Bible condemn doubt and many others specifically connect salvation to faith (e.g., John 3:16-18: “Whoever believes in him shall not perish but have eternal life...but whoever does not believe stands condemned...”)

#### 4.1.2 Rational faith

Given the assumptions above, the agent chooses  $\hat{\pi}$  given his prior  $\pi$  to maximize an expected utility  $U(\hat{\pi}, \pi) = \pi U_r(\hat{\pi}) + f(a^*(\pi), \pi) - p(\hat{\pi}, \pi)$ , where the term  $f(a^*(\pi), \pi)$  is a constant from the point of view of optimization. Thus, abusing notation to redefine  $U(\hat{\pi}, \pi)$  abstracting from this constant, we can write the agent’s problem as maximizing,

$$U(\hat{\pi}, \pi) = \pi U_r(\hat{\pi}) - p(\hat{\pi}, \pi), \tag{1}$$

which yields a solution  $\hat{\pi}(\pi) = \arg \max_{\hat{\pi}} U(\hat{\pi}, \pi)$ . It is straightforward to show that the agent will either choose a belief of 1 (full faith) or  $\pi$  (the agent’s prior). To see this, note that if  $\hat{\pi} < 1$ , the agent will receive no spiritual payoff in the religious state, yielding utility  $-p(\hat{\pi}, \pi)$ , which is maximized at 0 when  $\hat{\pi} = \pi$ . Alternatively, if  $\hat{\pi} = 1$ , the agent will choose a non-optimal action but receive the spiritual payoff, yielding utility  $\pi u_r - p(1, \pi)$ . This payoff is increasing in  $\pi$  and will be positive for some type  $\pi' \in (0, 1)$  since  $p(1, 1) = 0$ . We then establish:

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<sup>26</sup>The result in our first Lemma below that a positive measure of types choose a full belief  $\hat{\pi} = 1$  may seem to directly stem from this assumption, but it does not. All that is required, were we to allow  $U_r(\hat{\pi})$  to be continuously increasing and differentiable as  $\hat{\pi} \rightarrow 1$ , is that  $\frac{dU_r(\hat{\pi})}{d\hat{\pi}} > 0$  in a neighborhood of  $\hat{\pi} = 1$ , by virtue of the fact that  $p(\hat{\pi}, \pi)$  has slope zero at  $\hat{\pi} = \pi$ . In addition, the qualitative results on elasticity established later will hold with a continuously increasing function  $U_r(\hat{\pi})$  if  $p(\hat{\pi}, \pi)$  is not too convex given the other parameters in the model.

**Lemma 1** *If  $u_r > 0$ , then there exists a type  $\pi' \in (0, 1)$  such that all types  $\pi > \pi'$  choose to fully believe in the religious state (they set  $\hat{\pi} = 1$ ) and all types  $\pi < \pi'$  remain skeptics and retain their priors (they set  $\hat{\pi} = \pi$ ).*

Figure 2 displays the profile of chosen beliefs described in the lemma given initial priors. This profile reflects the tradeoff between faith and skepticism that is behind expression (1).

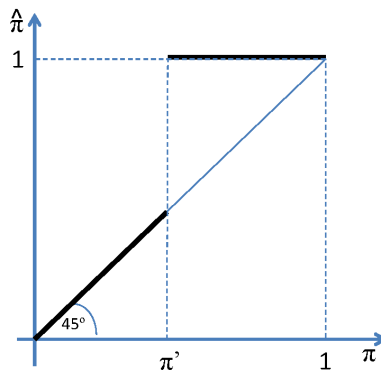


Figure 2: Graphical representation of theoretical model results: Chosen belief ( $\hat{\pi}$ : on y-axis) given prior beliefs ( $\pi$ : on x-axis)

The benefit of faith is the spiritual payoff in the religious state. The cost is a distortion of the selected action. For an agent with a very low prior, the cost of faith is high (because the action distortion is large) and the expected benefit is low because the perceived probability of a salvation payoff is low. As the prior rises, the cost monotonically falls, and the benefit monotonically rises, leading to an agent who is indifferent. For higher priors, the costs of distortion are lower than the expected salvation benefits, and agents choose full faith even if faith has costs and is not driven by information on the relative likelihood of the states of nature.

## 4.2 Modeling the experiment

Having formalized the basic driver of faith in the Pascalian spirit, we now enrich the model to explicitly consider how our experimental setup can achieve two objectives. The first is to elicit religious beliefs as just modeled. The second is to study when experimental

manipulation in the cost of holding beliefs can affect the number of those who “purchase” them at the cost of distorted decisions, following the basic law of demand.

As before, the agent chooses an action  $a$  that impacts a payoff  $f(a, \pi)$ . But now the agent also chooses an experimental action  $a_e$ . With probability  $1 - q$  this action is inconsequential. With complementary probability  $q$  the action  $a_e$  gives rise to an experimental payoff  $g(a_e, \pi)$ . In our design, the probability  $q$  of experimental payoff implementation varies across two different experimental conditions. We assume the experimental payoff function  $g(\cdot)$  satisfies the same assumptions as  $f(\cdot)$ , so it can be written as  $g(a_e, \pi) = g(a_e^*(\pi), \pi) - p_e(\hat{\pi}, \pi)$ , with the experimental penalty function  $p_e(\cdot)$  sharing the same properties as  $p(\cdot)$ . We will show later that the experimental payoff function that we implement satisfies these properties.<sup>27</sup> Both the action  $a$  and the experimental action  $a_e$  must be consistent with the chosen beliefs  $\hat{\pi}$ . The functions  $f(\cdot)$  and  $g(\cdot)$  make the model quite general. The key simplifying assumption is their being separate from each other, which is natural when the experiment generates monetary consequences and the action  $a$  involves life-style choices.<sup>28</sup>

#### 4.2.1 Timing

As in the basic model, there are three periods and no discounting. In the morning of period 1 the agent learns his prior  $\pi$  as before, and then chooses his belief  $\hat{\pi}_n$ , not knowing there will be an experiment in period 2.<sup>29</sup> In the evening of period 1 the agent learns about the experiment and possibly reoptimizes his beliefs to  $\hat{\pi}$  (if there is no reoptimization, then  $\hat{\pi} = \hat{\pi}_n$ ). In period 2 the agent chooses  $a$  and  $a_e$  (our results are robust to changing the timing so that  $a$  can be chosen before or after  $a_e$ ). In period 3 the religious state and the payoffs are realized. We now characterize the solution working backwards.

#### 4.2.2 Period 2: Choice of action in the experiment

Due to separability of  $f(\cdot)$  and  $g(\cdot)$ , we can abstract from decision  $a$  when studying behavior in the experiment. Given a belief  $\hat{\pi}$ , the agent will choose the experimental action to maximize  $g(a_e, \hat{\pi})$ . We now establish,

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<sup>27</sup>A slight difference between the implemented experimental mechanism and the stylized theoretical presentation here is that in the experiment the choice set was discrete rather than continuous.

<sup>28</sup>When the action  $a$  has monetary components (such as savings), then concavity of the utility for money makes the payoff consequences of  $a$  and  $a_e$  non separable. A previous version of the paper considered that case and established, at the cost of a more burdensome exposition, the same results shown here.

<sup>29</sup>The subscript  $n$  denotes the beliefs are chosen under no knowledge of the upcoming experiment. This is realistic (the subjects formed beliefs before knowing they would meet us) but also without loss: a case we will investigate below is equivalent to the subjects choosing  $\hat{\pi}_n$  knowing about the experiment.

**Proposition 1** *Given the assumptions on  $g(\cdot)$ , there is a unique optimal cutoff choice  $a_e(\hat{\pi})$  given a chosen belief  $\hat{\pi}$  in the Rapture, and  $a_e$  increases monotonically with  $\hat{\pi}$ .*

Proof: Follows directly from the proof to Lemma 1 given that  $f(\cdot)$  and  $g(\cdot)$  share the same properties. ■

This proposition tells us that experimental actions track chosen beliefs. As it will become clear below when we map the theory to the BDM scheme, if the structure of  $g(\cdot)$  is known then the chosen beliefs can be backed out from the experimental actions. The broader message of this result is that belief elicitation requires constructing an experimental payoff function  $g(\cdot)$  that, in the eyes of the subject, rewards actions that reflect her beliefs. In section (4.2.4) we connect the theory to the empirical identification strategy; we explain therein how we construct a proxy for the function  $g(\cdot)$  in our particular context.

### 4.2.3 Period 1: Choice of beliefs

We now study if changes in the experimental condition  $q$  can affect the choice of beliefs. This might occur given that the higher the probability  $q$ , the more payoff-relevant is the experimental penalty function  $p_e(\cdot)$ . The answer largely depends on the “stickiness” of beliefs. In the morning of period 1 the agent chooses a belief  $\hat{\pi}_n$  given the prior  $\pi$ . How does this agent react in the evening of period 1 when learning about the unexpected experiment? One possibility is that, once beliefs  $\hat{\pi}_n$  are chosen, beliefs remain invariant, so the final chosen belief  $\hat{\pi}$  equals  $\hat{\pi}_n$  and the experimental action choice will reflect  $\hat{\pi}_n$ . Changes in the experimental condition  $q$  will not induce any change in chosen beliefs since these were set permanently before the experiment became known. Another possibility is that an agent encountering an unexpected, financially relevant, experiment may choose to further revise her beliefs  $\hat{\pi}_n$ . In this situation, what interim prior  $\tilde{\pi}$  does she use to select  $\hat{\pi}$ ? We consider two opposite cases. In one case, the belief formed in the morning of period 1 becomes the prior used in the evening of that period ( $\tilde{\pi} = \hat{\pi}_n$ ). This would correspond to a case in which chosen beliefs are “sticky”: the agent has no recollection whatsoever of once having held a different prior  $\pi$ . In the other case, she is able to retrieve the fact that her prior was once  $\pi$ , not  $\hat{\pi}_n$ , and use  $\pi$  in her new maximization problem. Given  $\tilde{\pi} = \{\hat{\pi}_n, \pi\}$  and the experimental intervention, consider the problem of choosing  $\hat{\pi}$  to maximize:

$$U(\hat{\pi}, \tilde{\pi}; q) = (1 - q)[\tilde{\pi}U_r(\hat{\pi}) - p(\hat{\pi}, \tilde{\pi})] + q[\tilde{\pi}U_r(\hat{\pi}) - p(\hat{\pi}, \tilde{\pi}) - p_e(\hat{\pi}, \tilde{\pi})]. \quad (2)$$

With probability  $1 - q$  the BDM scheme will not be implemented, and thus the agent’s problem reduces to that in the basic model. But with probability  $q$  the scheme will be

implemented, and the agent will face an additional penalty from distorted decisions. Since the functions  $f(\cdot)$  and  $g(\cdot)$  satisfy the same assumptions, it is immediate that the problem yields a unique solution  $\hat{\pi}(\tilde{\pi}; q) = \arg \max_{\hat{\pi}} U(\hat{\pi}, \tilde{\pi}; q)$ .

As in the basic model, it is easy to show that the agent will choose  $\hat{\pi}$  to be either her interim prior ( $\hat{\pi} = \tilde{\pi}$ ) or a full belief ( $\hat{\pi} = 1$ ). As before, the agent might choose  $\hat{\pi} = 1$  in order to receive a spiritual payment in the state of the Rapture, even though this might distort action decisions. However, if  $\hat{\pi} < 1$  is chosen, the agent will not receive a spiritual payment and therefore desires no distortions in his actions  $a$  and  $a_e$ , leading to a choice of  $\hat{\pi} = \tilde{\pi}$ . Given this binary decision between 1 and  $\tilde{\pi}$ , we can now establish a result analogous to that in Lemma 1: there exists a type  $\tilde{\pi}'$  that separates believers from skeptics. The primary addition is that we now study whether the probability of experimental implementation  $q$  affects the separating type:

**Proposition 2** *a) (Skeptics and believers.) If  $u_r > 0$ , then there exists a type  $\tilde{\pi}'(q) \in (0, 1)$  such that all types  $\tilde{\pi} > \tilde{\pi}'(q)$  choose to fully believe in the religious state and all types  $\tilde{\pi} \leq \tilde{\pi}'(q)$  choose to remain skeptics (that is, they retain their interim priors).*

*b) (Short run elasticity of the demand for beliefs.) Consider  $q^0 > q$ .*

*b-1) If  $\tilde{\pi} = \hat{\pi}_n$ , then variations in  $q$  do not affect the measure of believers (i.e.,  $\tilde{\pi}'(q^0) = \tilde{\pi}'(q)$ ).*

*b-2) If  $\tilde{\pi} = \pi$ , a higher  $q$  reduces the measure of believers (i.e.,  $\tilde{\pi}'(q^0) < \tilde{\pi}'(q)$ ).*

This proposition establishes two results. First, that in the presence of the experiment we can still expect individuals to split into skeptics and full believers. Second, that if beliefs are not “sticky,” changes introduced by the experiment in the cost of holding beliefs may or may not induce changes in the demand for beliefs depending on one key aspect. This is whether, upon deciding to reoptimize beliefs, subjects utilize as their interim prior their chosen belief or the original prior. A corollary of part *b-2* of the proposition is that even if believers could react to changes in  $q$ , the experiment should show no effects of changes in  $q$  on the choices of skeptics. An increase in the cost of distorted beliefs should only reinforce the incentive of skeptics to retain their priors.

#### 4.2.4 Relation to the experiment and identification

The theoretical model describes a general experimental protocol to elicit the level and elasticity of religious beliefs. Here, we connect this abstract environment with our actual experiment to discuss how to interpret the decisions made by our subjects in light of the theory.

In our protocol the agent’s experimental action  $a_e$  is a cutoff decision in the range [\$1, \$500]. This cutoff expresses the lowest amount the subject would be willing to accept in

four weeks in exchange for an amount \$5 payable today. A first random draw determines if the experiment will be implemented, which occurs with probability  $q \in \{6\%, 50\%\}$  depending on the condition. If the experiment is implemented, a second draw  $y \in Y$ , where  $Y$  is a finite set of values with typical element  $y_i$  lying between 1 and 500, and where each value  $y_i$  is drawn with probability  $h(y_i)$ , with  $H(y_i)$  denoting the associated cumulative probability. If  $y \leq a_e$  then the subject gets paid \$5 through a present-dated check. If  $y > a_e$ , then the subject gets paid  $y$  through a check post-dated in four weeks. To check that this matches the theory presented before, note that using a continuous approximation to the discrete set  $Y$  and the distribution  $H$ , the agent's material payoff from the implementation of the experiment can be written as:  $H(a_e)u(5) + \delta(1 - \hat{\pi}) \int_{a_e}^{500} u(y)h(y)dy \equiv \tilde{g}(a_e, \hat{\pi})$ , where  $\delta$  captures a pure time discount factor. All payments  $y$  are multiplied by  $\delta(1 - \hat{\pi})$  since they occur in the future and can only be enjoyed if the Rapture does not occur. Note that  $\tilde{g}(a_e, \hat{\pi})$  is a direct analog of the function  $g(a_e, \hat{\pi})$  used in the abstract theoretical setup. The payoff  $\tilde{g}(a_e, \hat{\pi})$  is easily seen to be concave, and taking the first order conditions we immediately get that the agent's optimal cutoff is  $a_e^*(\hat{\pi}) = u^{-1}\left(\frac{u(5)}{\delta(1-\hat{\pi})}\right)$ , which is strictly increasing and approaches  $\infty$  as  $\hat{\pi}$  approaches 1. Given knowledge of  $u(\cdot)$  and  $\delta$ , one can directly back out the belief  $\hat{\pi}$ . In the case of risk neutrality, the belief satisfies,

$$\hat{\pi} = 1 - \frac{5}{\delta a_e^*}. \quad (3)$$

We will estimate  $\hat{\pi}$  for the FR members as follows. If SDA members claim to have no beliefs in the Rapture and make choices consistent with normal time discount rates, then we can use their experimental cutoffs to estimate  $\delta$  by setting  $\hat{\pi} = 0$  in (3). Then, under the assumption that pure time preference is the same across groups, plugging the cutoffs chosen by FR subjects in (3) yields an estimate of their beliefs. Note that this method will overestimate subjects' true beliefs in the Rapture if they are risk averse. However, we will demonstrate that our qualitative conclusions hold strongly even in the face of quite extreme risk aversion.

## 5 Results

### 5.1 Participant Summary Statistics

Table 1 contains summary statistics for both the FR (columns 1 and 2) and SDA (columns 3 and 4) samples, split by group and condition. Columns 5 and 6 contain p-values of tests of equality across treatment conditions. No observable characteristics are significantly different across treatment conditions, within samples. Note that some questions in Table 1 were

asked after the experimental intervention and therefore could have been influenced by the treatment; however, given the benign nature of the experimental variation, along with the fundamental importance of the post-experiment survey questions, we believe this type of bias is unlikely to have occurred.

The first two rows of Table 1 show that subjects from both samples are of middle age and slightly more than half are male; these characteristics are balanced within groups. Furthermore, comparing between two groups, the FR and SDA samples are indistinguishable in terms of gender and age (tests not shown). Table 1 also empirically confirms many of the claims we have made thus far concerning the beliefs of Family Radio and SDA members. Perhaps not surprisingly, the vast majority of Family Radio members stated that they believed Harold Camping’s prophecy with certainty and had spent significant time “spreading the word.” Very few SDA members believed that May 21st was the day of Judgement, despite the fact that 80% had heard about Harold Camping’s prophecy. Figure 3 contains the empirical distribution of these beliefs for both samples as captured through a survey instrument. The beliefs of FR subjects are extreme in that very few hold interior beliefs, in line with the theoretical predictions of our model.<sup>30</sup> Later we will compare this picture with the one stemming from the incentivized elicitation.

Subjects from both groups expressed uncertainty about whether they would be raptured on Judgement Day. This likely stems from scripture such as *Revelation 14:3-4*, which states that only a small number of people (specifically, 144,000) will be raptured, and *Romans 3:10*, which states that “no one is righteous.” Some subjects may have felt that expressing certainty in one’s Rapture prospects was a violation of biblical authority, whereas others felt comfortable doing so.

Overall, the summary statistics confirm that SDA members are similar in many respects to FR members, but rather than having a date-specific Judgement Day belief, most believe it will come at some unspecified time in the future (which is consistent with Church doctrine). SDA members put positive probability on Judgement Day happening within their lifetime, with an average of about 40% probability. This is further evidence that large, closer to mainstream, religious groups such as the SDA hold what many would consider “extreme” beliefs. For example, the question “What is life going to be like on Earth after Judgement Day?” yielded similar responses from both samples, centering on destruction, chaos, and suffering.

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<sup>30</sup>SDA members could also be seen to hold extreme beliefs, which in light of our model could reflect low original priors or a low threshold  $\pi'$  separating skeptics and believers.

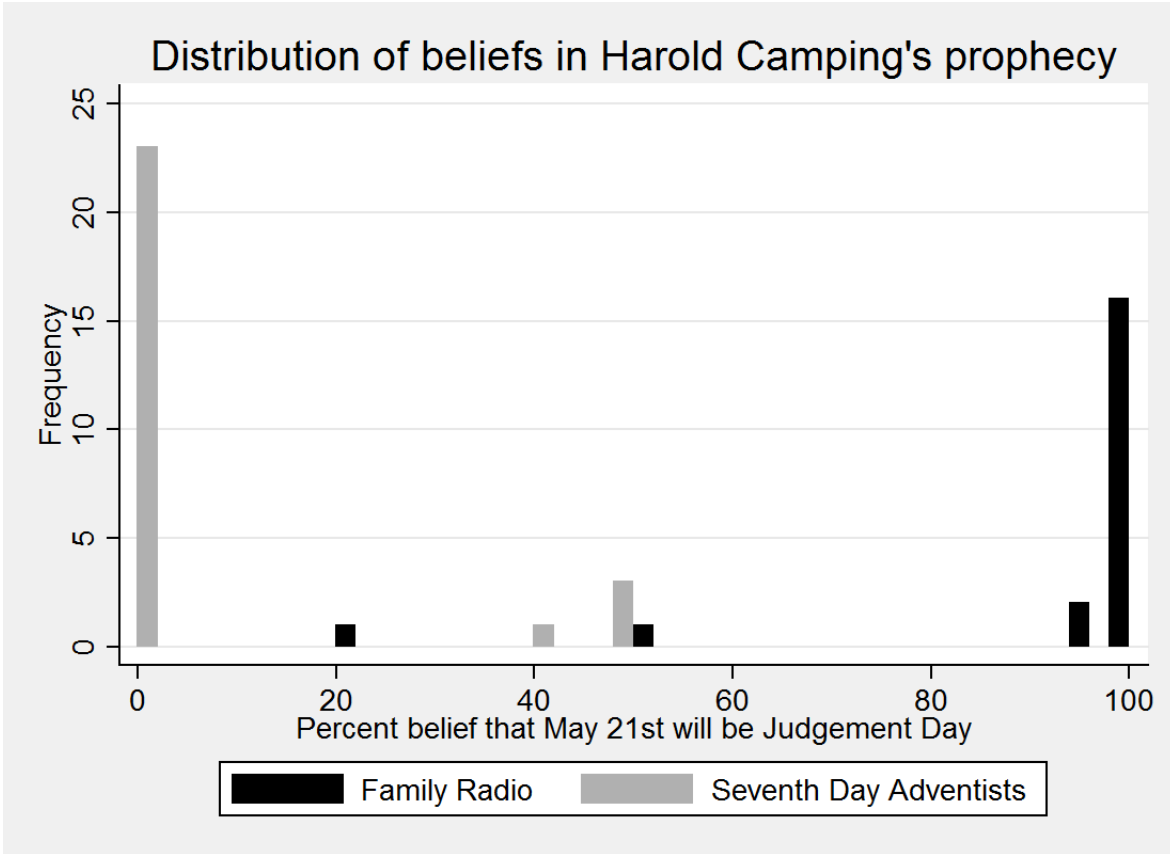


Figure 3: Histogram of stated beliefs in the prophecy, for both experimental samples.

## 5.2 Experimental Findings

Figure 4 contains the main results of the experiment. The histogram contains cutoff values—that is, the minimum amount of money a subject was willing to accept in four weeks in exchange for \$5 today—for each of the FR and SDA samples, separating the 6% and 50% conditions. Visually it is clear that the FR and SDA groups lie on opposite extremes. The distributions of cutoffs are statistically different across the two groups regardless of whether one separates the two conditions or pools them. Panel A of Table 2 reports results by pooling the 6% and 50% conditions. The p-value for a Wilcoxon Rank Sum test of different distributions of cutoffs across the groups is less than 0.01.

Table 2 also shows that the average cutoff for SDA subjects was about \$20 and the median was \$8. Taking this median, SDA members chose to delay payment for a “reasonable” time-discount one month out of  $5/8 = 0.625$ , which lies within the range of values found by laboratory studies (Frederick, Loewenstein, and O’Donoghue 2002) (using the mean also yields a comparable discount). This suggests that the bulk of SDA survey responses indicat-



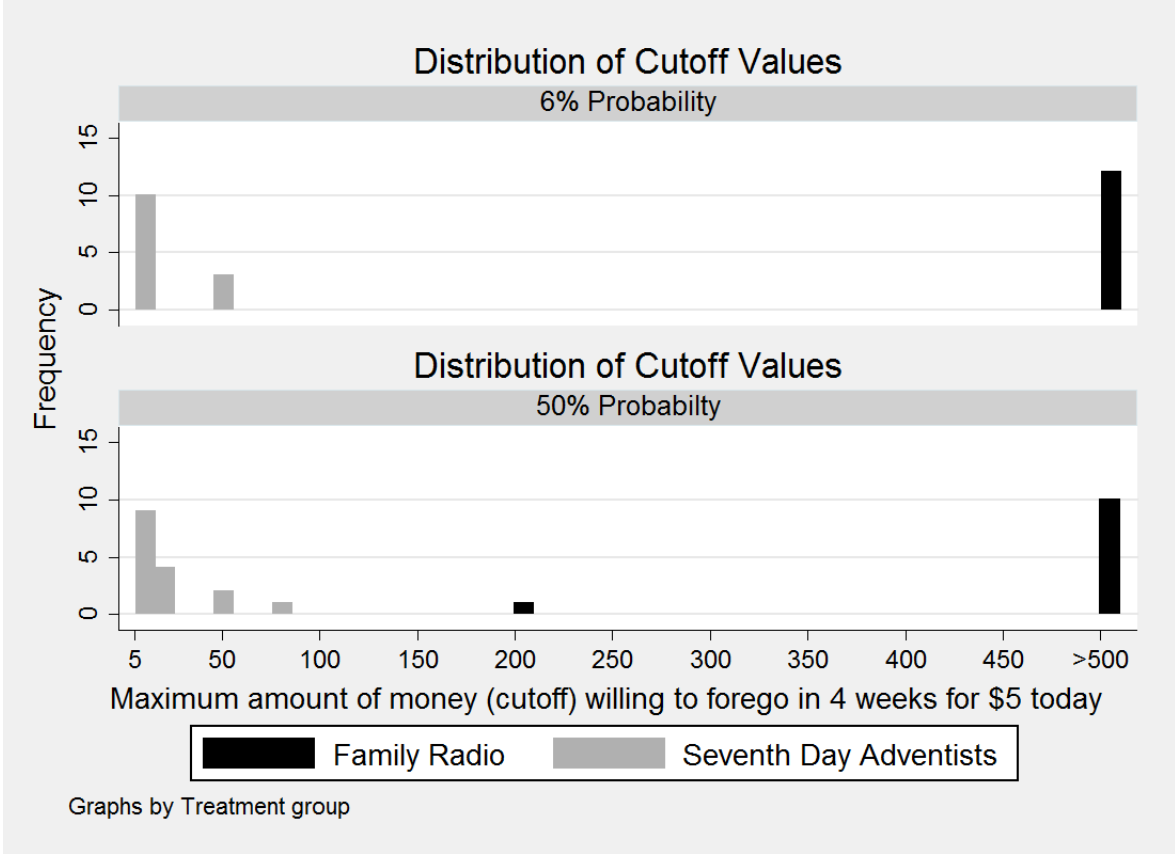


Figure 4: Histogram of cutoff values by treatment condition, for both experimental samples.

ing no belief in the prophecy were sincere, and we can take their median discount factor as our estimate for  $\delta$ . In contrast, FR members chose very large cutoffs: *only one subject chose a cutoff less than \$500* (specifically, a \$200 cutoff, by a subject who in the survey declared less than full beliefs in the prophecy). All other FR subjects declared to prefer \$5 today to any amount up to \$500 payable one month out. This is compatible with cutoffs much higher than \$500, and potentially infinite. To be conservative, we impute a cutoff of \$500 for these subjects. This yields a median cutoff among FR subjects of \$500, and an average of \$487.

What do the cutoffs chosen by FR members imply in terms of the strength of their beliefs in the Rapture? Using the formula in (3) we now compute the implied beliefs under the assumption of risk neutrality, using the SDA discount factor to approximate  $\delta$ . Taking the median cutoff for the FR members (equal to \$500), the implied belief in the Rapture is  $\hat{\pi} = 1 - \frac{5}{0.625 \times 500} = 98.6\%$ . If we take the average cutoff for the FR members (equal to \$487), the implied belief in the Rapture is virtually identical: 98.56%. Note that these are conservative estimates: if the cutoffs we impute as \$500 are replaced with larger figures the

estimated value of  $\hat{\pi}$  will get even closer to 100%.<sup>31</sup> This is consistent with the unincentivized question in the survey, where FR members expressed certainty about the Rapture. The fact that the cutoffs chosen by SDA members are compatible with previous estimates of time preference provides reassurance that the cutoffs chosen by the FR members were likely not an artifact, but instead reflect strong and *sincere* beliefs in the May 21st prophecy.<sup>32</sup>

As made clear in Figure 4, there is no visible difference across conditions within the Family Radio and the SDA groups. This is borne out in the statistical tests reported in Panel B of Table 2. This table displays cutoff means and medians across conditions for each group, as well as their differences and the associated non-parametric p-values. There are no significant differences across conditions for either group.

### 5.3 Discussion of Results

Our experiment is designed to detect different beliefs in the Rapture occurring within one month of the date of the experiment. People with different beliefs about the likelihood of the world continuing as usual face different intertemporal tradeoffs and thus should select different cutoffs when faced with the BDM mechanism. Indeed, the FR subjects, who claimed to believe in the Rapture, selected very different cutoffs from the SDA subjects, who did not claim to have strong beliefs on the May 21 date. The fact that by choosing a cutoff beyond \$500 the FR members forgo the possibility of earning up to \$500 dollars after the Rapture in exchange for \$5 today, suggests a discount rate that is much higher than that of SDA members. Such a discount rate is compatible with a sincere, full belief in the Rapture and the bunching of beliefs at an extreme is compatible with the Pascalian wager logic of the model. Given the recency of the FR message and the similarity of FR and SDA subjects in their general theological makeup, the concentration of FR subjects on full beliefs in the Rapture is hardly attributable to a preexisting bunching in the priors of the FR subjects. In other words, faith in the prophecy appears compatible with the logic of the model, in

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<sup>31</sup>It is easy to show that if SDA members have non-zero beliefs in the Rapture, the computed belief for FR members will only rise and therefore our estimate can again be seen as a lower bound. Lastly, the reader may wonder about our use of a discrete elicitation mechanism. Given the median of \$8 (or, alternatively, the average of \$20) for the SDA cutoffs, it is conceivable that the true cutoffs lie in between 8 and 9 for the median or 20 and 22 for the average (see Figure 1). Taking any value in the interval between the declared notch and the next discrete value available in the scale yields an even higher estimate of  $\hat{\pi}$  for the FR subjects.

<sup>32</sup>Even extreme risk aversion does not change our qualitative results. By way of illustration, consider a person with greater than \$100 of wealth and a certainty equivalent \$100 for a fifty-fifty gamble over zero and \$500 (that is, quite extreme risk aversion). Given a CRRA utility function ( $u(c) = \frac{c^{1-\rho}}{1-\rho}$ ) or a CARA utility function ( $u(c) = 1 - e^{-\alpha c}$ ), our calculation in the text would change from a lower bound of 98.6% to a lower bound of 97.1% and 94.6%, respectively.

which a will to believe plays a role. That a will to believe is present is also supported by the specific context of our experiment. No unequivocal evidence was ever adduced that could support certainty in the prophecy; rather, Camping’s arguments relied on the interpretation of biblical passages that are metaphorical and ambiguous. In non-religious contexts it is well known that ambiguity creates room for self-serving manipulation of beliefs (Babcock and Loewenstein (1997) present and review relevant evidence).

The fact that cutoffs are not significantly different across conditions can also be rationalized through proposition 2. SDA members are skeptics, and as such they do not respond to changes in the price of beliefs, since an increase in the price  $q$  of holding beliefs in the Rapture can only reinforce their skepticism. But in addition we find no evidence of elasticity in the case of FR members. This is compatible with the idea that full believers only use their chosen beliefs as the basis for any further belief reoptimization, as explained in part  $b$  of the proposition. No recollection of having once held different priors appears to play a role in their optimization.

It is worth listing some caveats to this interpretation. An alternative explanation for the lack of evidence of a price-elasticity of beliefs is that internalizing a new incentive structure may take time. In addition, even if individuals were to utilize long-abandoned priors to reoptimize, evidence of changes in the marginal believer would have required a significant fraction (rather than just one person) of the FR group making choices compatible with more normal discount rates in the 50% (high cost) condition. The small number of FR subjects we encountered could have had original priors relatively far away from the marginal type  $\pi'(q)$ , and they behave exactly as the model predicts inframarginal types will, by maintaining their full belief. Perhaps, detecting price effects would have required a larger sample, or larger changes in  $q$  coupled with stronger incentives.

An aspect of our experiment that might merit variation in future research is that the subjects were approached at the very end of a group activity. It is conceivable that subjects could feel more inclined to make choices consistent with a full belief in the prophecy in that situation, perhaps even to make a statement toward the experimenters. The possibility of expressive utility driving responses is more acute in the context of surveys, and research in political science shows that incentivized elicitation of opinions on political facts sharply reduces the partisan bias seen in surveys (Bullock and Huber 2013). Our evidence points to extreme beliefs rather than just bias. We show that introducing and varying nontrivial stakes has no discernible impact, nor creates a wedge between survey and incentivised responses.<sup>33</sup> This suggests the presence of true beliefs rather than purely expressive motives. Also, if

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<sup>33</sup>It is worth noting that the one FR subject who expressed interior beliefs in the survey also chose an interior cutoff in the experiment.

experimenter demand effects are likely stronger on survey than incentivised responses, the close correspondence between the two types of responses across conditions tends to alleviate concerns with demand effects.

One drawback to this experiment is that we could not explore a larger range of prices. For example, would true believers have been able to pass up \$5000, \$500,000, or \$5,000,000 in order to actively entertain the idea that the Judgement Day would not happen on May 21st? IRB restrictions prevented us from using larger sums that could be considered coercive. In addition, in attention to the possibility of preference falsification, going into the experiment we considered the possibility that offering larger probabilities of drawing the highest balls would make the experiment very costly to run.

## 5.4 Epilogue: Adjusting to the Prophecy Failure

We noted earlier that the vast majority of Family Radio members reported that they were a 100% certain that the Rapture would occur on May 21st, 2011. Their responses to the incentivized time-preference experiment were consistent with this belief. However, the Rapture did not occur on May 21st. How did the Family Radio members react?

After May 21st it became extremely difficult to contact Family Radio members directly.<sup>34</sup> Fortunately, in addition to the large number of news reports following the event, many members continued to participate in a online forum dedicated to the discussion of the May 21st prophecy. The message board was hosted on Yahoo! and was open to the public to read, but required joining the group with moderator approval in order to post messages.<sup>35</sup> We downloaded all 1538 message board posts one month before and one month after May 21, 2011, and instructed a research assistant to encode the message content in a quantitative format (such as noting quoted Bible verses, mentioned dates, subjective ranking of emotional tone, etc.).

The initial prediction about the timing of the Rapture was very specific. According to Harold Camping, the Rapture would begin in the first time zone to experience sunset on May 21st (UTC+12, which contains New Zealand) and travel around the world as the sun set on different time zones. In the preceding days, the message board largely included messages about faith, hope, and goodbyes to other members. The board was relatively quiet in the few hours preceding and following the predicted starting time. A few hours after this time, some members began to speculate about what was (or was not) happening. The messages

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<sup>34</sup>Our protocol as approved by IRB required and assured anonymity, and therefore we could not recontact FR members. To our knowledge, the group did not meet publicly after May 21.

<sup>35</sup>The forum, with all posted messages, is located at [http://groups.yahoo.com/group/TimeandJudgment\\_May212011/](http://groups.yahoo.com/group/TimeandJudgment_May212011/).

revealed an anxiety for a resolution that would maintain the central tenets of the prophecy.

A manifestation of that sentiment involved posts putting forth alternative future dates for the Rapture. The new dates tended to involve minimal amendments to the original theory, typically predicting the Rapture to occur within one day of the posting. For example, two hours after the originally predicted Rapture time, the moderator of the board posted a 6,600 word essay about a potential error in Camping’s interpretation of time, suggesting that the Rapture would occur at Midnight in Jerusalem time. This theory was endorsed by eight other posts in the next few hours. Immediately after that time passed, someone noted that the previous theory had not taken Daylight Savings Time into account, potentially extending the margin by another hour. Following the passing of each new predicted time, a new revision was immediately suggested and the group coalesced on that time. This active revision of the prediction with dates very close to May 21st continued until about the time Camping reappeared on May 23rd. He then stated that the “spiritual judgement” that is part of the Rapture had occurred indeed, albeit without any visible signs. He also stated that creation would still be destroyed on October 21st, 2011.

It is interesting to note the re-setting of dates after a failed prophecy is quite typical of apocalyptic groups (Kyle 1998). For example, following the Millerites’ failed prophecy of 1843, a large faction of the group quickly converged on March 21, 1844 as a new date for the End of the World, and when that date passed uneventfully, new dates in 1874, then 1878, then 1881 were adopted by the leaders that would go on to form the Jehovah’s Witnesses.<sup>36</sup>

The FR members’ pattern of behavior of adjustments can be cast in terms of a demand and supply of predictions and narratives. Given the failure of the original prediction, the “consumers” in this market for apocalyptic predictions attempted the production of their own predictions. This process lasted until the “official” supplier of such predictions—Camping, in the FR case—produced a new one. This demand for predictions provides another suggestion that individuals have a demand for beliefs, one that can only be exercised if there is something—in this case a prediction—to believe in.

## 6 Related literature

Our paper relates to two main literatures, one on the economics of religion and another on belief anomalies and manipulation. Religion has, of course, attracted vast attention in the

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<sup>36</sup>The other main faction went on to become the Seventh Day Adventist Church. As has been seen, this group maintained the belief that Judgement Day is near, but abandoned date-setting. In their book on failed prophecies Festinger, Riecken, and Schachter (2009) illustrate how the disconfirmation of beliefs triggers a variety of responses involving adjustments in beliefs and narratives.

social sciences and we will not attempt a broad survey here. The literature on the supply side of the market for religion is well surveyed by Iannaccone (1998). Here we will cover work that more directly relates to the theme of the demand for religion.

Although the demand side of religion has received relatively less attention, progress has been made in understanding the phenomenon of conversion. Ensminger (1997) relies on a transactions costs approach to account for conversion patterns to Islam as a function of the advantages of membership to trading networks. In a similar vein, Levy and Razin (2011) model a context where conversion (real or apparent) confers signaling benefits toward further social interaction. Compatible with that logic, economics fundamentals related to geography and trade feature prominently in recent empirical work on adherence to Islam (Michalopoulos, Naghavi, and Prarolo (2012) and Barro, Hwang, and McCleary (2010)). An interesting challenge is to empirically disentangle the causal links between economic fundamentals, true beliefs, and conversion. Such investigation would benefit from a way to measure beliefs more reliably, and the incentivized approach we offer may be of help.

Closer to our framework, Durkin and Greeley (1991) formalize the Pascalian wager and take their model to the data. Both their theory and empirics equate beliefs to religious participation.<sup>37,38</sup> While highly valuable, that approach mixes two different elements, beliefs and actions, with an unclear direction of causation between them. For example, Pascal argued that beliefs probably cannot be chosen directly, but that through the adoption of outwardly religious actions one would come to develop religious beliefs (Pascal (1668), p. 69).<sup>39</sup> Whether this proposition is true or the opposite holds (rather, beliefs drive religious activity) is hard to evaluate empirically before progress is made in the measurement of beliefs; hopefully our work contributes a step in that direction.

A commonality among the above papers on the demand for religion is that they either hinge on instrumental motives to be (or appear to be) religious or sidestep the issue of the sincerity of faith. In contrast, we focus on sincere beliefs and explicitly consider how beliefs affect expected utility through separate channels: as probability weights in the interim

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<sup>37</sup>A substantial literature in philosophy has examined both the logic and premises of the Pascalian wager (e.g., Hacking (1972), Hajek (2003)), notably the assumption that the returns to belief are infinite in the state that God exists.

<sup>38</sup>Palacios-Huerta and Santos (2004) study a demand for religion following a more distant approach—they consider an evolutionary competitive argument for religious preferences based on reduced risk aversion against uninsurable states.

<sup>39</sup>Still, Pascal has been criticized for proposing a cold mechanical calculation as a potential path to faith. James (II{6}) considers that critique eloquently: “We feel that a faith in masses and holy water adopted wilfully after such a mechanical calculation would lack the inner soul of faith’s reality; and if we were ourselves in the place of the Deity, we should probably take particular pleasure in cutting off believers of this pattern from their infinite reward.” However, James concludes that volitional aspects are crucial and make Pascal’s argument ultimately valid.

expected utility function and as arguments of a state-contingent utility function that gives beliefs instrumental value in an ex ante expected utility sense.

This brings us to consider the literature on the manipulation of beliefs. One strand of theoretical work has studied an individual's incentive to manipulate the information she has about herself for instrumental reasons such as improving performance through confidence or to overcome self-control problems (see for instance Carrillo and Mariotti (2000), Bénabou and Tirole (2004), and Compte and Postlewaite (2004)). Another strand has examined incentives to manipulate beliefs (about the self or about the environment) stemming from intrinsic reasons, namely that individuals care about beliefs directly. For example, such manipulation may be driven by anticipatory utility (see inter alia Brunnermeier and Parker (2005), Köszegi (2006), Bénabou and Tirole (2006), and Dal Bó and Tervio (2013)).

Behavioral economists have identified ways in which subjective belief updating appears to be non-Bayesian. Incentivized laboratory experiments have shown that subjects tend to give more weight to materially self-serving information (Babcock and Loewenstein 1997; Babcock, Loewenstein, Issacharoff, and Camerer 1995) and to positive (as compared to negative) information about a quality they directly care about, such as intelligence or physical attractiveness (Eil and Rao 2011; Möbius, Niederle, Niehaus, and Rosenblatt 2010). These results are suggestive of belief manipulation, but are also compatible with a hard-wired processing bias toward the positive.<sup>40</sup> Other studies document overconfidence about personal attributes using unincentivized surveys (Svenson 1981). Such departures, however, may be due to limitations in the quality of available feedback (Benoit and Dubra 2011) and a multi-attribute signal space (Santos-Pinto and Sobel 2005). Optimism has been documented in connection with the performance of others when the subject cares about them, such as sports teams (Massey, Simmons, and Armor 2011). While sports fervor and religiosity may show many parallels, the beliefs documented in the sports realm appear to contain a partial bias. Religion is associated with a full belief, both in surveys and in our incentivized elicitation.

## 7 Conclusion

A better understanding of faith, that is, of strong beliefs that are by definition not driven by evidence in the logical or statistical sense, is an important task for the economics of religion, and one that may yield insights into decision-making more broadly. In this paper, we study faith through the prism afforded by a recent apocalyptic prophecy. This prophecy allowed us

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<sup>40</sup>For example, Balci and Dunning (2006) document biases occurring in visual perception with very short (30-100ms) decision time frames.

to conduct what to our knowledge is the first ever incentivized elicitation of religious beliefs.

Our experiment is framed by a theoretical model that incorporates the logic of the Pascalian wager, but can be extended to incorporate a richer set of psychological motives, such as anticipation. The key driver in the model is the rational manipulation of beliefs once these enter as arguments in a state-contingent utility function. Our model predicts manipulation of beliefs towards complete faith for a certain set of priors. It also explains how the experimental intervention can establish the presence of sincere religious beliefs and yield estimates of their response to changes in the cost of holding them.

Our evidence indicates the existence of a sincere belief in the end of the world by members of the apocalyptic group. The main import of this finding is to highlight the role of sincere faith in a particular religious belief system, beyond other, mundane, motivations that could affect the demand for religion. In addition, our data suggests that the beliefs are inelastic to changes in costs, although this result may be dependent on a small sample size, or pertinent to the short run only. According to our theory, the unresponsiveness of beliefs to changing costs may reflect the fact that choice-driven beliefs are incorporated as the relevant priors to be employed in subsequent belief reoptimization.

One might be concerned that studying decisions by members of an apocalyptic group can say little about the formation of beliefs by other people. After all, those members choose to hold a belief that seems unwarranted by available evidence. But as forcefully argued by James (1909), this is a habit affecting everyone to varying degrees, and a defining feature of faith. In addition, a review of the apocalyptic scholarship establishes that apocalyptic themes are central to the past, and in some cases the present, of mass religious movements, all of which involve many other articles of faith with similar standards of proof. In other words, apocalypticism shares important commonalities with other religious beliefs, and hence, in our view, offers a valuable research vehicle into faith.

Partly through its limitations, our study suggests some avenues for future research. Future projects could consider contacting subjects separately rather than at the end of a collective activity, as well as involve larger samples and larger prizes. The idea of using incentivized elicitation schemes in combination with falsifiable religious statements could be extended to other settings; for instance, one could use our approach to study beliefs in the power of prayer to alter observable outcomes. Lastly, in light of our results, it would be important to enrich the market analysis of religion; the demand side could include sincere faith as an active and distinct component that may interact with other motivations to demand religious services.



## References

- Akerlof, G. A. and W. T. Dickens (1982). The economic consequences of cognitive dissonance. *The American Economic Review* 72(3), 307–319.
- Babcock, L. and G. Loewenstein (1997). Explaining Bargaining Impasse: The Role of Self-Serving Biases. *The Journal of Economic Perspectives*, 109–126.
- Babcock, L., G. Loewenstein, S. Issacharoff, and C. Camerer (1995). Biased Judgments of Fairness in Bargaining. *The American Economic Review*, 1337–1343.
- Balcetis, E. and D. Dunning (2006). See what you want to see: Motivational influences on visual perception. *Journal of Personality and Social Psychology* 91(4), 612.
- Barro, R., J. Hwang, and R. McCleary (2010). Religious conversion in 40 countries. *Journal for the Scientific Study of Religion* 49(1), 15–36.
- Barro, R. and R. McCleary (2006). Religion and political economy in an international panel. *Journal for the Scientific Study of Religion* 45(2), 149–3175.
- Barro, R. J. and R. M. McCleary (2003). Religion and Economic Growth. *American Sociological Review* 66(5), 760–781.
- Becker, G., M. DeGroot, and J. Marschak (1964). Measuring utility by a single-response sequential method. *Behavioral Science* 9, 226–232.
- Bénabou, R. and J. Tirole (2004). Willpower and personal rules. *Journal of Political Economy* 112(4), 848–886.
- Bénabou, R. and J. Tirole (2006). Incentives and prosocial behavior. *American Economic Review* 96(5), 1652–1678.
- Benoit, J. and J. Dubra (2011). Apparent overconfidence. *Econometrica*, forthcoming.
- Brunnermeier, M. K. and J. A. Parker (2005). Optimal Expectations. *The American Economic Review* 95(4), 1092–1118.
- Bullock, J., G. A. H. S. and G. Huber (2013). Partisan bias in factual beliefs about politics. *NBER Working Paper No. 19080*.
- Camping, H. (2005). *Time has an End: A History of the World 11,013 B.C. to 2011 A.D.* Vantage Press.
- Carrillo, J. D. and T. Mariotti (2000). Strategic ignorance as a self-disciplining device. *Review of Economic Studies* 67(3), 529–44.

- Clingingsmith, D., A. I. Khwaja, and M. Kremer (2009). Estimating the impact of the hajj: Religion and tolerance in islam’s global gathering. *The Quarterly Journal of Economics* 124(3), 1133–1170.
- Cohen, D. (1983). *Waiting for the Apocalypse*. Prometheus Books.
- Cohn, N. (1957). *The Pursuit of the Millennium*. Secker & Warburg, London.
- Compte, O. and A. Postlewaite (2004). Confidence-enhanced performance. *American Economic Review* 94(5), 1536–1557.
- Dal Bó, E. and M. Tervio (2013). Self-esteem, moral capital, and wrongdoing. *Journal of the European Economic Association* 11(3), 599–663.
- Durkheim, E. (1915). *The Elementary Forms of Religious Life*. Free Press.
- Durkin, J. and A. Greeley (1991). A model of religious choice under uncertainty: On responding rationally to the nonrational. *Rationality and Society* 3(2), 178–196.
- Eil, D. and J. M. Rao (2011). The Good-News Bad-News Effect: Asymmetric Processing of Objective Information about Yourself. *American Economic Journal: Microeconomics*, 529–544.
- Eliade, M. (1954). *The Myth of the Eternal Return*. New York: Pantheon Books.
- Ensminger, J. (1997). Transaction costs and islam: Explaining conversion in africa. *Journal of Institutional and Theoretical Economics (JITE)* 153(1), 4–29.
- Festinger, L., H. Riecken, and S. Schachter (2009). *When Prophecy Fails*. Pinter & Martin Limited.
- Finer, S. E. (1997). *The History of Government from the Earliest Times, Vols. I-III*. Oxford University Press.
- Frederick, S., G. Loewenstein, and T. O’Donoghue (2002). Time discounting and time preference: A critical review. *Journal of economic literature* 40(2), 351–401.
- Hacking, I. (1972). The logic of pascal’s wager. *American Philosophical Quarterly* 9(2), 186–192.
- Hajek, A. (2003). Waging war on pascal’s wager. *Philosophical Review* 112(1), 27–56.
- Hoffman, R. (2012). The Experimental Economics of Religion. *Journal of Economic Surveys*, 41–71.
- Huber, J. (2005). Religious Belief, Religious Participation, and Social Policy Attitudes Across Countries. *Columbia University, mimeo*.

- Huber, J. D. and P. Stanig (2011). Church-state separation and redistribution. *Journal of Public Economics* 95(7-8), 828–836.
- Iannaccone, L. R. (1998). Introduction to the Economics of Religion. *Journal of Economic Literature* 36(3), 1465–1495.
- James, W. (1909). *The Will to Believe and Other Essays in Popular Philosophy*. E-Book 26659 The Project Gutenberg <<http://www.gutenberg.org/files/26659/26659-h/26659-h.htmP1>>.
- Karni, E. (2009). A mechanism for eliciting probabilities. *Econometrica* 77(2), 603–606.
- Kőszegi, B. (2006). Ego utility, overconfidence, and task choice. *Journal of the European Economic Association* 4(4), 673–707.
- Krosnick, J. A. and S. Presser (2009). The theory of the firm. In J. D. Wright and P. V. Marsden (Eds.), *Handbook of Survey Research*. Elsevier.
- Kuran, T. (1995). *Private Truths, Public Lies: The Social Consequences of Preference Falsification*. Harvard University Press.
- Kuran, T. (1997). Islam and Underdevelopment: An Old Puzzle Revisited. *Journal of Institutional and Theoretical Economics* 153(1), 41–71.
- Kyle, R. (1998). *The Last Days are Here Again: A History of the End Times*. Baker Books (Grand Rapids, Mich.).
- Levy, G. and R. Razin (2011). Religious Beliefs, Religious Participation and Cooperation. *Working Paper*.
- Massey, C., J. P. Simmons, and D. A. Armor (2011). Hope over experience: Desirability and the persistence of optimism. *Psychological Science* 22, 274–281.
- McGinn, B. (1998). *Visions of the End: Apocalyptic Traditions in the Middle Ages*, Volume 96. New York: Columbia Univ Press.
- Michalopoulos, S., A. Naghavi, and G. Prarolo (2012). Trade and geography in the origins and spread of islam. NBER Working Papers 18438.
- Möbius, M., M. Niederle, P. Niehaus, and T. Rosenblatt (2010). Self-confidence Management: Theory and Empirical Evidence. *Working paper*.
- Montgomery, J. D. (1996). Contemplations on the Economic Approach to Religious Behavior. *The American Economic Review: Papers and Proceedings* 86(2), 443–447.
- Palacios-Huerta, I. and T. J. Santos (2004). A theory of markets, institutions, and endogenous preferences. *Journal of Public Economics* 88(3-4), 601–627.

- Pascal, B. (1668). *Pascal's Pensees (English translation by John Walker)*. Available online at <http://www.gutenberg.org/files/18269/18269-h/18269-h.htm>.
- Rowley, H. H. (1943). *The Relevance of Apocalyptic: A Study of Jewish and Christian Apocalypses From Daniel to the Revelation*. London: Lutterworth Press.
- Santos-Pinto, L. and J. Sobel (2005). A model of positive self-image in subjective assessments. *American Economic Review*, 1386–1402.
- Scheve, K. and D. Stasavage (2006). Religion and Preferences for Social Insurance. *Quarterly Journal of Political Science* 1(3), 255–286.
- Svenson, O. (1981). Are we all less risky and more skillful than our fellow drivers? *Acta Psychologica* 47(2), 143–148.
- Wagar, W. W. (1982). *Terminal Visions: the Literature of Last Things*. Bloomington, Indiana: Indiana University Press.

## 8 Appendix

We first establish the claim in the text that the assumptions on  $f(a, \pi)$  imply that  $a^*(\pi) = \arg \max_a f(a, \pi)$  is unique and strictly increasing in  $\pi$ . To see this, note that for a given  $\pi$ ,  $f(a, \pi)$  is a continuous, strictly concave, function with support on a closed set and therefore has a unique maximum. As  $\frac{\partial^2 f(a, \pi)}{\partial a \partial \pi} > 0$ ,  $f(a, \pi)$  is supermodular and therefore  $a^*(\pi)$  is strictly increasing in  $\pi$ .

We next establish the claim in the text that the assumptions on  $f(a, \pi)$  imply that the implicit penalty  $p(\hat{\pi}, \pi)$  is minimized at 0 when  $\hat{\pi} = \pi$ , and increasing as  $\hat{\pi}$  deviates farther from  $\pi$  ( $\frac{\partial p(\hat{\pi}, \pi)}{\partial \hat{\pi}} \leq 0$  for  $\hat{\pi} \leq \pi$ ). To see this, recall that  $p(\hat{\pi}, \pi) = f(a^*(\pi), \pi) - f(a^*(\hat{\pi}), \pi)$ . Clearly,  $p(\pi, \pi) = 0$ . Note that  $\frac{\partial p(\hat{\pi}, \pi)}{\partial \hat{\pi}} = -\frac{\partial f(a^*(\hat{\pi}), \pi)}{\partial a^*(\hat{\pi})} \frac{\partial a^*(\hat{\pi})}{\partial \hat{\pi}}$ . Focus on the case in which  $\hat{\pi} < \pi$ . Then,  $a^*(\hat{\pi}) < a^*(\pi)$ . As  $f(a, \pi)$  is strictly concave in  $a$ ,  $\frac{\partial f(a, \pi)}{\partial a} > 0$  if  $a < a^*(\pi)$ . Therefore,  $\frac{\partial f(a^*(\hat{\pi}), \pi)}{\partial a^*(\hat{\pi})} > 0$ . We have previously established that  $\frac{\partial a^*(\hat{\pi})}{\partial \hat{\pi}} > 0$  and therefore  $-\frac{\partial f(a^*(\hat{\pi}), \pi)}{\partial a^*(\hat{\pi})} \frac{\partial a^*(\hat{\pi})}{\partial \hat{\pi}} < 0$  if  $\hat{\pi} < \pi$ . Similar logic shows that  $-\frac{\partial f(a^*(\hat{\pi}), \pi)}{\partial a^*(\hat{\pi})} \frac{\partial a^*(\hat{\pi})}{\partial \hat{\pi}} > 0$  if  $\hat{\pi} > \pi$ .

**Proof of Lemma 1:** For an agent with prior  $\pi$ , the payoff from choosing  $\hat{\pi} = 1$  is  $U(1, \pi) = \pi u_r - p(\hat{\pi}, \pi)$  and the payoff from choosing  $\hat{\pi} < 1$  is  $U(\hat{\pi}, \pi) = -p(\hat{\pi}, \pi)$ . Note that, given the properties of  $-p(\hat{\pi}, \pi)$ , an agent with  $\pi < 1$  and choosing  $\hat{\pi} < 1$  attains a maximum payoff of 0 by setting  $\hat{\pi} = \pi$  and therefore any agent choosing  $\hat{\pi} < 1$  must choose  $\hat{\pi}(\pi) = \pi$ . Now note that  $U(\hat{\pi}, 0) = -p(\hat{\pi}, 0)$  which is maximized at  $\hat{\pi} = 0$ , so  $\hat{\pi}(0) = 0$ . By continuity of  $p(\hat{\pi}, \pi)$ , for any finite value  $u_r$  there exists a positive measure of types above  $\pi = 0$  who also choose  $\hat{\pi}(\pi) = \pi$ . Now note that  $\hat{\pi}(1) = 1$  as  $U(1, 1) = u_r > 0$

and  $U(0, 1) = -p(0, 1) < 0$ . Finally, note that  $U(1, \pi)$  is continuous and increasing in  $\pi$  given the properties of  $p(\hat{\pi}, \pi)$  and therefore there exists some type  $\pi' \in (0, 1)$  such that  $U(1, \pi') = 0 = U(\pi', \pi')$ . Therefore, for all types  $\pi > \pi'$ ,  $U(1, \pi) > 0$  and  $\hat{\pi}(\pi) = 1$  while for all types  $\pi < \pi'$ ,  $U(1, \pi) < 0$  and  $\hat{\pi}(\pi) = \pi$ . ■

**Proof of Proposition 1:** Let us abstract from the spiritual payoff  $U_r$ , which cannot be affected by actions, and from the constant terms  $f(a^*(\pi), \pi)$  and  $g(a_e^*(\pi), \pi)$ . Then in period 2 the agent who has chosen beliefs  $\hat{\pi}$  and considers a probability  $q$  that the BDM scheme will be implemented chooses actions  $a$  and  $a_e$  to maximize  $(1 - q)[f(a, \hat{\pi})] + q[f(a, \hat{\pi}) + g(a_e, \hat{\pi})]$ . The separability of  $f$  and  $g$  implies that the choice of  $a_e$  is independent of that of  $a$ . And since  $g$  satisfies the same assumptions as  $f$ , it has a maximum at  $a_e^*(\hat{\pi})$  which is increasing in  $\hat{\pi}$ . ■

**Proof of Proposition 2: (a)** Note that  $p(\hat{\pi}, \tilde{\pi}) + q(p_e(\hat{\pi}, \tilde{\pi}))$  has the same properties as  $p(\hat{\pi}, \tilde{\pi})$  (minimized at  $\hat{\pi} = \tilde{\pi}$ , decreasing (increasing) for  $\hat{\pi} < \tilde{\pi} (> \tilde{\pi})$ ). Then, the logic in the proof of Lemma 1 implies that, for a given  $q$ , there exists a type  $\tilde{\pi}'(q)$  such that for all types  $\tilde{\pi} > \tilde{\pi}'(q)$ ,  $U(1, \tilde{\pi}; q) > 0$  and  $\hat{\pi}(\tilde{\pi}) = 1$ , while for all types  $\tilde{\pi} < \tilde{\pi}'(q)$ ,  $U(1, \tilde{\pi}; q) < 0$  and  $\hat{\pi}(\tilde{\pi}) = \tilde{\pi}$ . The type  $\tilde{\pi}'(q)$  satisfies  $U(1, \tilde{\pi}'(q); q) = \tilde{\pi}'u_r - p(1, \tilde{\pi}') - q(p_e(1, \tilde{\pi}')) = 0$ .

**(b-1)** The proof of Lemma 1 implies that  $\hat{\pi}_n(\pi)$  takes the form of  $\hat{\pi}_n(\pi) = 1$  when  $\pi > \pi'_n$  and  $\hat{\pi}_n(\pi) = \pi$  when  $\pi < \pi'_n$ , where  $\pi'_n$  is the unique point  $\pi'_n \in (0, 1)$  where  $U(1, \pi'_n) = \pi'_nu_r - p(1, \pi'_n) = 0$ . Part a) of this proof implies that  $\hat{\pi}(\tilde{\pi})$  takes the same form with a critical point  $\tilde{\pi}'(q) \in (0, 1)$  where  $U(1, \tilde{\pi}'(q); q) = \tilde{\pi}'u_r - p(1, \tilde{\pi}') - q(p_e(1, \tilde{\pi}')) = 0$ . Note that  $\hat{\pi}'_n$  stems from the basic model, which can be obtained from the expanded model with the experiment by setting  $q = 0$ . Thus,  $\hat{\pi}'_n = \hat{\pi}'(q = 0)$ . Now we claim that the critical point  $\tilde{\pi}'(q)$  with  $q > 0$  must be larger than the critical point  $\pi'_n$ . Note that  $U(1, \pi'_n; q) < U(1, \pi'_n) = 0$  as  $-q(p_e(1, \pi'_n)) < 0$  given  $\pi'_n < 1$ . As  $U(1, \tilde{\pi}; q)$  is increasing, it must be that  $\tilde{\pi}'(q) > \pi'_n$  for  $U(1, \tilde{\pi}'(q); q) = 0$  to be satisfied. Now, consider the function  $\hat{\pi}(\hat{\pi}_n; q)$ . Recall that  $\hat{\pi}(\tilde{\pi}; q) = 1$  if  $\tilde{\pi} = 1$ . Recall that  $\hat{\pi}_n = 1$  for any  $\pi > \pi'_n$ . Therefore,  $\hat{\pi}(\hat{\pi}_n; q) = 1$  for any  $\pi > \pi'_n$ . Recall that  $\hat{\pi}(\tilde{\pi}; q) = \tilde{\pi}$  if  $\tilde{\pi} < \tilde{\pi}'(q)$ . Recall that  $\hat{\pi}_n = \pi$  for any  $\pi < \pi'_n < \tilde{\pi}'(q)$ . Therefore,  $\hat{\pi}(\hat{\pi}_n; q) = \hat{\pi}_n = \pi$  for any  $\pi < \pi'_n$ . As a result,  $\hat{\pi}(\hat{\pi}_n; q) = \pi$  for any  $\pi < \hat{\pi}'_n$ , and  $\hat{\pi}(\hat{\pi}_n; q) = 1$  for any  $\pi \geq \hat{\pi}'_n$ , yielding  $\hat{\pi}(\hat{\pi}_n; q) = \hat{\pi}(\hat{\pi}_n; 0)$  which is invariant in  $q$ .

**(b-2)** As stated above, part (a) of this proof implies that  $\hat{\pi}(\tilde{\pi})$  takes the form of  $\hat{\pi}(\tilde{\pi}) = 1$  when  $\pi > \tilde{\pi}'$  and  $\hat{\pi}(\tilde{\pi}) = \pi$  when  $\pi < \tilde{\pi}'$ , where  $\tilde{\pi}'$  is the unique point  $\tilde{\pi}' \in (0, 1)$  to solve  $U(1, \tilde{\pi}'(q); q) = \tilde{\pi}'u_r - p(1, \tilde{\pi}') - q(p_e(1, \tilde{\pi}')) = 0$ . Consider  $q^0 > q$ . We claim that the critical point  $\tilde{\pi}'(q^0)$  must be larger than the critical point  $\tilde{\pi}'(q)$ . Note that  $U(1, \tilde{\pi}'(q); q^0) < U(1, \tilde{\pi}'(q); q) = 0$  as  $U(1, \tilde{\pi}'(q); q^0) - U(1, \tilde{\pi}'(q); q) = -(q^0 - q)p_e(1, \tilde{\pi}'(q)) < 0$  given  $\tilde{\pi}'(q) < 1$ . As  $U(1, \tilde{\pi}; q)$  is increasing in  $\tilde{\pi}$ , it must be that  $\tilde{\pi}'(q^0) > \tilde{\pi}'(q)$  for  $U(1, \tilde{\pi}'(q^0); q^0) = 0$  to be satisfied. Therefore, an increase from  $q$  to  $q^0$  reduces the measure of types that choose  $\hat{\pi} = 1$  from  $1 - \tilde{\pi}'(q)$  to  $1 - \tilde{\pi}'(q^0)$ . ■

Table 1: Summary statistics for Family Radio and Seventh-day Adventist experimental groups, by treatment.

	Family Radio Sample			7 <sup>th</sup> Day Adventist Sample		
	6%	50%	p-value	6%	50%	p-value
	Treatment (1)	Treatment (2)	(1) = (2) (3)	Treatment (4)	Treatment (5)	(4)=(5) (6)
Age	42.09 (5.85)	40.67 (5.22)	0.86	33.50 (4.74)	38.60 (4.55)	0.44
Male	0.73 (0.14)	0.44 (0.17)	0.21	0.55 (0.16)	0.50 (0.13)	0.82
Percent belief that the rapture will occur on May 21st	95.00 (4.51)	90.56 (8.71)	0.65	8.33 (5.62)	6.07 (4.15)	0.75
Had heard about the group that believes May 21st will be the Judgement Day	--	--	--	0.75 (0.13)	0.87 (0.09)	0.47
With what percent chance do you believe the Rapture will occur within your lifetime?	--	--	--	30.00 (9.95)	45.67 (10.78)	0.30
Hours spent per week in "spreading the news" that May 21st is Judgement Day *	3.71 (0.54)	2.91 (0.78)	0.41	--	--	--
Percent belief in being saved (raptured) on Judgement Day **	86.11 (7.10)	77.86 (14.45)	0.61	60.00 (11.56)	73.33 (11.06)	0.41
Percent belief that the End of the World will occur on October 21st, conditional on seeing no visible signs that the Judgement Day occurred on May 21st ***	84.36 (9.68)	79.44 (13.16)	0.77	--	--	--
Observations	12	11		13	16	

(1) Robust standard errors in parentheses.

(2) \* This continuous measure of hours spent per week was asked categorically in the questionnaire, with a maximum choice of six hours per week.

(3) \*\* For the Family Radio group, this question was phrased as "With what percent chance do you believe you will be raptured (saved) on May 21st, 2011?" For the SDA group, it was phrased as "If the rapture happens within your lifetime, with what percent chance do you believe you will be raptured (saved) on Judgment Day?"

(4) \*\*\* Five subjects refused to answer because they would not entertain the possibility that Judgement Day would not happen

Table 2: Cutoff values for Family Radio and Seventh-day Adventist experimental groups, by treatment.

<b>Panel A: Pooled conditions</b>						
	Family Radio		7th Day Adventist	p-value		
	(1)	(2)	(3)	(1)=(2)		
Cutoff value						
Mean	486.96 (13.01)	19.07 (3.67)	0.00			
Median	500 (0)	8 (2.83)	0.00			
Observations	23	29				

<b>Panel B: Non-pooled conditions</b>						
	Family Radio Sample			7th Day Adventist Sample		
	6% Treatment	50% Treatment	p-value (1)=(2)	6% Treatment	50% Treatment	p-value (4)=(5)
	(1)	(2)	(3)	(4)	(5)	(6)
Cutoff value						
Mean	500.00 (0.00)	472.73 (27.07)	0.32	16.77 (5.26)	20.94 (5.23)	0.58
Median	500 (0)	500 (0)	--	7 (5.28)	12 (4.74)	0.18
Observations	12	11		13	16	

Notes:

(1) Robust standard errors in parentheses. Median standard errors and p-values are bootstrapped.

(2) We code a subjects' cutoff as \$500 if they chose "I prefer \$5 today" (see text); note that no subject, in either sample, chose a cutoff of exactly \$500.