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USING AN APOCALYPTIC PROPHECY TO ELICIT RELIGIOUS BELIEFS IN THE FIELD

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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 then demonstrate how an experimental intervention can exploit standard elicitation techniques to measure religious belief by varying prizes associated with making choices contrary to one's belief in a, crucially, falsifiable religious proposition. We implemented this approach with a group that expected the "End of the World" to happen on May 21, 2011 by offering prizes payable before and after May 21st. The results suggest the existence of a demand for extreme, sincere beliefs that was unresponsive to experimental manipulations in price.

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1 Introduction

Religion has shaped human cognition and social relations since the origin of civilization (Durkheim 1915); it has also undergirded power structures before modern institutions such as markets, firms, or professionalized 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.¹ 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.² Therefore, 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.

Understanding faith is important, since it is arguably the more distinctive element in the market for religion. The nature of religious attachments might affect market adjustments to shocks in income or new scientific knowledge, as well as how religion interacts with modern institutions. Additional important questions, such as whether faith drives religious activity, or conversely, whether religious activity drives beliefs, also require an understanding of faith. Unfortunately, faith has not received much attention in economics, most likely because its study poses the great empirical hurdle of ascertaining religious beliefs reliably. Religious beliefs typically involve propositions that are non-falsifiable, making it difficult to incentivize the revelation of those beliefs. Without any incentives, social pressures to conform may induce people to exaggerate (or downplay) their faith to peers or surveyors. Furthermore, “revealed preference” approaches are also flawed: social returns may drive participation in religious activities above and beyond what strict belief would warrant.³ Despite the long history of religion in human affairs, to our knowledge religious beliefs have never been

¹In 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.

²See 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 (Clingsmith, Khwaja, and Kremer 2009).

³Kuran (1983) elaborates on the fact that pressures to conform may lead to a falsification of preferences. Huber (2005) investigates the cross-national determinants of the wedge between religiosity (as beliefs) and religious participation (as an external activity).

measured scientifically. As a result, a complete foundation for the study of the demand side of religion seems out of reach.

In this paper we propose an approach to measuring religious beliefs—their sincere level and elasticity—that can serve as a basis for a systematic study of the demand side of religion. The key requirement is to locate religious propositions that are (presumably) believed in, and are also falsifiable. Then we can rely on standard belief elicitation techniques that reward predictions based on their accuracy. In addition, we can experimentally manipulate the cost of holding different beliefs. We demonstrate our approach using the well publicized prophecy made by Harold Camping, an elderly Christian radio talkshow 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 judgment 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.

We elicited beliefs in the End of the World prophecy by running a time-preference experiment in the weeks prior to May 21st. The experiment embodied an elicitation mechanism exploiting a key aspect of the beliefs espoused by Family Radio followers, namely that money would have no value after May 21st: money would be worthless either 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.⁴ 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 us, did not consider May 21st a special date.⁵ We offered both the Family 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 (Becker, DeGroot, and Marschak (1964), henceforth, BDM) method to capture the exact amount payable post May 21st that would make the subject indifferent with \$5 today. For the control group,

⁴In 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, both informally and through a survey we implemented *a posteriori* of the experimental interaction.

⁵Seventh 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 statistics are available at www.adventist.org/world-church/facts-and-figures/index.html.

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 control group. If their beliefs were sincere, we would expect their revealed discount rates to be higher. We also varied the probability of implementation of the mechanism within the groups to affect the cost of beliefs and to see if beliefs are price-sensitive.

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, regardless of the probability of implementation. At the same time, 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, with little apparent elasticity. This finding underscores the role of sincere faith in the demand side of religion, and simultaneously rules out two alternatives: evidence-based beliefs, and faith-related activities that occur exclusively due to social factors.

Our experiment and theoretical model were designed to meet important conceptual challenges facing an economics approach to faith. The main difficulty is that traditional economic theories conceptualize beliefs as driven by evidence, yet faith is defined as beliefs that are not backed by evidence.⁶ We remain committed to an economics approach in that we investigate faith as beliefs that, although driven by choice rather than evidence, are still compatible with a rational management of material and psychological tradeoffs. In this spirit, a natural starting point is the best known argument for a rational choice to believe, 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.⁷ We refine Pascal’s logic by clearly separating actions from beliefs, dispensing with infinite Heavenly payoffs, and integrating the logic of the wager into an intertemporal choice problem, which allows us to define the notion of a demand for 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

⁶According 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.

⁷As it turns out, Pascal offered three arguments, not one, anticipating possible objections. To the most 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 initially strong skeptics Pascal invoked infinite payoffs from Heaven.

the world that are verifiable, rewards for accurate predictions are possible, and beliefs can be elicited. Our finding that Family Radio members truly believed in the prophecy establishes the existence of a demand for beliefs.

In the model, agents have different prior beliefs on the truth of a religious prediction about the physical world and can choose what posterior beliefs to hold. The benefit of manipulating beliefs is that under a doctrine of “salvation through belief,” beliefs can add to expected utility at the cost of inducing distorted actions (relative to the action that would be taken under the prior belief); the model predicts the existence of a marginal individual 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 purely rational argument can drive a gulf between extreme believers and skeptics—something that we see in the data. The marginal member determines the size of the “aggregate demand for beliefs,” and being indifferent, she would choose to remain a skeptic if the price of beliefs went up, while those with inframarginal priors should still choose to believe fully. This finding prompted our experimental design of randomly assigning a high or a low chance that the cutoff choice in the BDM scheme would be implemented, which changes the cost of manipulating posterior beliefs away from the prior. We found that the choices of the Family Radio subjects were not statistically significant across the two conditions, which is compatible with there being no marginal members in the sample.

Our primary contribution of developing and implementing an approach for the elicitation of sincere religious beliefs is not dependent on the origin of those beliefs. However, our conceptualization of a demand for beliefs as an active choice, and the expectation that beliefs may be price-elastic, prompt the observation that religious beliefs may reflect other mechanisms. These range from pathology to the unwillingness to consider information contradicting beliefs inculcated in early age or received from a trusted authority figure. This would be in line with the cognitive dissonance literature (e.g., Festinger (1957), Akerlof and Dickens (1982)). In response to these possibilities, it is worth noting that, as we will discuss in our next section, scholars researching apocalyptic ideas have long emphasized that beliefs in such prophecies are common in history and cannot be attributed to pathology. Rather, they share important tenets with religion more generally. In addition, our empirical setting favors interpreting the demand for beliefs of the Family Radio members as an active choice. The prophecy constituted a new prediction and thus beliefs in it could not have been inculcated in early age, it was disputed by most Christian authorities, and its associated group displayed remarkably low social cohesion. In addition, belief in the prediction hinged on choosing how to resolve scriptural ambiguities and contradictions in a way that is a matter of choice. Thus, if there is an ideal empirical setting to study the role of a “decision to

believe” in the demand for religion, ours comes very close to it.

An additional observation is that reports are common of people making material sacrifices for the sake of their religiosity, so those acts must already reflect a “willingness to pay” for religion. But it is important to rule out actions that may be taken for signaling purposes, rather than out of inner conviction. 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, and not a matter of anecdotal reports by third parties or by the putative believers.

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 2011.⁸ 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.⁹ 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.”

Camping’s evidence for this prediction largely relies on biblical exegesis and numerology.

⁸More information can be found at <http://fsiforms.familyradio.org/stations/search.php>

⁹This 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.

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.”¹⁰ 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 passages as metaphorically referring to the end of times, in a way that is ultimately a matter of choice. 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 Judgment 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.

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 history of apocalyptic ideas affords reasons not to attribute apocalyptic beliefs, including those of Camping’s followers, to 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,

¹⁰In 1992, Camping wrote *1994?* (Camping 1992), 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.”

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.¹¹

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 Judgment 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 Judgment 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 Jehova’s Witnesses have believed in a series of Judgment Day dates since 1843, while as we stated earlier, the SDA Church evolved as a branch that rejects date-setting.

¹¹A 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 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.

3 Model

We now develop a model where individuals choose their religious beliefs. First we model individual behavior in the absence of experimental interaction, and then we explicitly model the way in which the experiment would help characterize religious beliefs. Our model is tightly tailored to the case of the Rapture and the logic of the Pascalian wager. However, the logic of the model extends directly to religious beliefs more generally, and it can accommodate a richer set of psychological motives, such as anticipatory utility.¹² That richer version of the theory is available upon request.

3.1 Basic setup

3.1.1 Structure and payoffs

There are two periods, 1 and 2. In period 2, one of two states of nature will be realized: the “status quo” or the “Rapture.” There is a continuum of agents characterized by their prior belief π that the status quo state will occur. Agents are initially endowed with m units of a consumption good. The agent chooses an amount a to save for period 2, leaving $m - a$ for consumption in period 1. We assume that the agent’s utility from consuming c is $u(c)$, with $u(\cdot)$ satisfying $u(0) = 0$, $u' > 0$, $u'' < 0$, and $u'(0) = \infty$.

The payoff in period 2 depends on the realized state of the world. If the status quo is realized, the agent consumes savings a . Alternatively, if the Rapture is realized, the agent receives no consumption (in line with the stated beliefs of the FR members), but receives a

¹²Such augmented version incorporates more fully the suggestions in Montgomery (1996) on the possible ways forward for an economics-based conceptualization of faith. While a model including factors like anticipatory utility and cognitive dissonance would add realism, here we stick with the most parsimonious version that delivers the results of interest.

spiritual payment U_r , which we discuss shortly. For simplicity, we assume that agents do not discount consumption in period 2.

At the beginning of period 1 an agent has prior belief $\pi \in [0, 1]$ in the status quo. Our setting contains two deviations from standard economic models. One is that the first decision the agent gets to make is to *choose* a belief $\hat{\pi} \in [0, 1]$ in the status quo. This choice of belief will affect the agent’s payoff through two channels. First, chosen beliefs will affect savings decisions, as we require that after choosing her belief, the agent’s saving decision be consistent with the chosen belief $\hat{\pi}$.¹³ Second, and here we introduce the other nonstandard feature of our setup, the chosen belief $\hat{\pi}$ may “earn Heaven.” Specifically, we model the spiritual payoff U_r as a function of chosen beliefs $\hat{\pi}$:

$$U_r(\hat{\pi}) = \left\{ \begin{array}{ll} u_r \geq 0 & \text{if } \hat{\pi} = 0 \\ 0 & \text{otherwise} \end{array} \right\}$$

We make the payoff discontinuous to capture the beliefs of FR members (and many religions) that salvation is conditional on *full faith* in the religious doctrine. The type of discontinuity plays an important role in Pascal’s arguments and, according to Durkheim, it is an empirically sound assumption, “The first article in every creed is the belief in salvation by faith” (Durkheim (1915), p. 416). The assumption of this discontinuity is *not necessary* for our main results, but does make exposition more transparent.¹⁴

To summarize the timing, in period 1 the agent begins by choosing her beliefs $\hat{\pi}$, and then she chooses her savings a . In period 2 the state of nature is realized and the agent either consumes her savings or enjoys the spiritual payoff u_r .

3.1.2 Rational faith

As we stated above, we require that the agent’s saving decision be consistent with the chosen belief. Therefore, given a belief $\hat{\pi}$, the agent’s savings must maximize $u(m - a) + \hat{\pi}u(a) + (1 - \hat{\pi})U_r$, yielding optimal savings $a(\hat{\pi})$ characterized by the first order condition $u'(m - a) = \hat{\pi}u'(a)$.

The agent chooses $\hat{\pi}$ anticipating the implied savings function. It is straightforward to show that the agent will either choose a belief of 0 (full faith) or π (the agent’s prior). To see this, note that if $\hat{\pi} > 0$, the agent will receive no spiritual payment in the Rapture state, yielding expected utility $u(m - a(\hat{\pi})) + \pi u(a(\hat{\pi})) + (1 - \pi) \times 0$. This function is maximized

¹³This 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)).

¹⁴The qualitative results of inelasticity will hold with a continuously increasing function $U_r(\hat{\pi})$ if $u(c)$ is not “too concave” given the other parameters in the model.

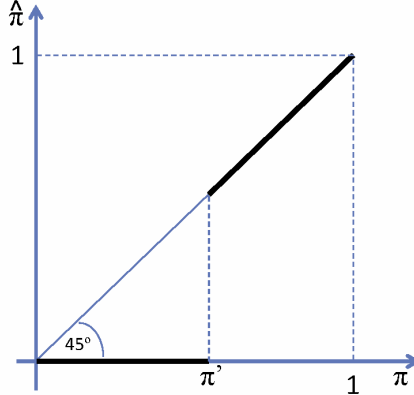


Figure 1: Graphical representation of theoretical model results: Chosen belief ($\hat{\pi}$:on y-axis) given prior beliefs (π : on x-axis)

when the agent chooses the optimal savings given π , which occurs by setting $\hat{\pi} = \pi$, yielding expected utility $u(m - a(\pi)) + \pi u(a(\pi)) + (1 - \pi) \times 0$. Therefore, if the agent chooses $\hat{\pi} > 0$, it must be that $\hat{\pi} = \pi$. It is possible that the agent will choose $\hat{\pi} = 0$ given the discontinuity in the spiritual payoff function. Although the implied savings will be zero (leading to zero consumption utility in the status quo state), the agent expects to receive a spiritual payment in the Rapture state, yielding expected utility $u(m) + \pi u(0) + (1 - \pi) u_r$.

Therefore, the agent's decision (when $\pi > 0$) can be summarized by the following program (resolving indifference in favor of full faith in the Rapture):

$$\text{Max}_{\hat{\pi} \in \{0, \pi\}} [u(m) + (1 - \pi) u_r, u(m - a(\pi)) + \pi u(a(\pi))] \quad (1)$$

We then establish:

Lemma 1 *If $u_r > 0$, then there exists a type $\pi' \in (0, 1)$ such that all types $\pi \leq \pi'$ fully believe in the Rapture and all types $\pi > \pi'$ remain skeptics (that is, they retain their priors).*

Proof: See appendix.

The Figure 1 displays the profile of chosen beliefs given initial priors. This result captures the tradeoff between full belief and following one's prior. The benefit of full belief is the spiritual payment in the Rapture state. The cost is a distortion of the optimal savings decision (toward no savings). For an agent with a sufficiently low prior on the status quo,

the benefit of adopting full religious belief is relatively high (because the prior suggests a high probability that the spiritual payment will be realized) and the cost is relatively low (because the prior suggests a low probability of savings consumption and the savings distortion is small). As the prior rises, the benefit monotonically falls and the cost monotonically rises, leading to an agent who is indifferent.

3.2 Modeling the experiment

Having formalized the basic driver of faith, we now enrich the model to explicitly consider how our experimental setup can achieve two objectives. The first is to elicit chosen beliefs and thus establish their sincerity. The second is to study whether changes in the cost of holding beliefs decreases the numbers of those who “purchase” them at the cost of distorted decisions, following the basic law of demand.

3.2.1 Elicitation mechanism and timing

As the timing with the experiment is more involved, it will prove practical to describe it while detailing our elicitation mechanism. First, agents choose beliefs $\hat{\pi}$. They then choose a cutoff k , expressing the lowest amount they would be willing to receive in period 2 in exchange for an amount $v_1 > 0$ today (in the experiment, v_1 was equal to \$5). A first random draw determines if the experiment will be implemented, which occurs with probability q . If the experiment is implemented, a second draw $v_2 \in [v_1, \infty)$ is taken from an atomless distribution $F(v_2)$ with associated density $f(v_2)$ (in the experiment, v_2 was drawn between \$5 and \$500). If $v_2 \leq k$ then the agent gets paid v_1 in period 1. If $v_2 > k$, then the agent gets paid v_2 in period 2. After the uncertainty of the experiment is resolved in period 1 the agent chooses savings a .

As before, we require that the agent’s cutoff and savings decision be *consistent* with the chosen belief. That is, the agent must choose each decision as if the true probability of the status quo is $\hat{\pi}$. Note that the savings decision is now more complicated, as the implementation of the experiment impacts the wealth of the agent in one of the periods. To keep track of these eventualities, we denote optimal savings as $a(\hat{\pi}, I_1 v_1, I_2 v_2)$, where I_i is an indicator function equal to 1 if the experiment triggers a payment in period i . For example, $a(\hat{\pi}, 0, v_2)$ denotes the optimal savings decision given that the agent will receive an additional v_2 in period 2.

We solve the model by working backwards. Note that neither the savings decision or the cutoff choice can affect the spiritual payment, which is solely a function of $\hat{\pi}$.

3.2.2 Savings Choices

The agent selects savings a consistent with beliefs $\hat{\pi}$ and with the outcome of the experiment. If the experiment is not implemented, the agent chooses savings $a(\hat{\pi}, 0, 0)$ as in the basic model above. If the experiment is implemented and v_2 is below the chosen cutoff $k(\hat{\pi})$, the agent must choose $a(\hat{\pi}, v_1, 0)$ to maximize perceived expected utility $u(m + v_1 - a) + \hat{\pi}u(a)$. If the experiment is implemented and $v_2 \geq k$, the agent must choose $a(\hat{\pi}, 0, v_2)$ to maximize perceived expected utility $u(m - a) + \hat{\pi}u(a + v_2)$.

3.2.3 Cutoff Choices

The agent selects a cutoff k that is consistent with beliefs $\hat{\pi}$ prior to the experiment. Note that the cutoff only affects the agent's utility if the experiment is implemented. In the case of implementation, consistency requires that the agent's choice of cutoff k maximize expected utility as if the true probability of the status quo is $\hat{\pi}$, which is given by

$$\begin{aligned} & F(k) [u(m + v_1 - a(\hat{\pi}, v_1, 0)) + \hat{\pi}u(a(\hat{\pi}, v_1, 0))] + \\ & + \int_k^\infty [u(m - a(\hat{\pi}, 0, v_2)) + \hat{\pi}u(a(\hat{\pi}, 0, v_2) + v_2)] f(v_2) dv_2 \\ & + (1 - \hat{\pi})U_r(\hat{\pi}) \end{aligned} \quad (2)$$

The choice of cutoff k is entirely analogous to the choice in a typical BDM-style elicitation mechanism. If the agent prefers to receive v_1 in period 1 to some v_2'' in period 2, the agent can choose a cutoff k above v_2'' to ensure that v_1 is received instead of v_2'' if the second draw is v_2'' . Alternatively, if the agent prefers v_2'' in period 2, the agent can choose a cutoff k below v_2'' to ensure that v_2'' is received if the second draw is v_2'' . Therefore, the agent can choose the cutoff point that makes her indifferent between receiving that amount in period 2 and receiving v_1 in period 1, and receive her preferred choice given any draw of v_2 .

Note that, for a chosen belief of $\hat{\pi} = 0$, equation (2) reduces to,

$$F(k) [u(m + v_1)] + \int_k^\infty [u(m)] f(v_2) dv_2 + u_r, \quad (3)$$

which makes clear that a full believer holding $\hat{\pi} = 0$ will want to expand k towards infinity.

We now state:

Proposition 1 Consider $q > 0$.

a) (**Truthful revelation.**) The agent will choose the unique cutoff $k^*(\hat{\pi})$ defined by the following implicit equation: $u(m + v_1 - a(\hat{\pi}, v_1, 0)) + \hat{\pi}u(a(\hat{\pi}, v_1, 0)) = u(m - a(\hat{\pi}, 0, k^*)) + \hat{\pi}u(a(\hat{\pi}, 0, k^*) + k^*)$.

b) (**Cutoffs track beliefs.**) The cutoff $k^*(\hat{\pi})$ is weakly decreasing in $\hat{\pi}$. More specifically, $\frac{\partial k^*}{\partial \hat{\pi}} \leq 0$ and $\frac{\partial k^*}{\partial \hat{\pi}} < 0$ if $k(\hat{\pi}) > v$.

c) (**The demand for beliefs is detectable.**) Full believers in the Rapture have an infinite cutoff (i.e., as $\hat{\pi} \rightarrow 0$ we have $k^* \rightarrow \infty$).

d) (**Cutoffs are a known linear function of beliefs under risk neutrality.**) If $u(c) = c$, $k(\hat{\pi}) = \frac{v_1}{\hat{\pi}}$ for $\hat{\pi} \in (0, 1]$.

e) (**Cutoffs of the risk averse.**) If $u''(c) < 0$ and $m > \frac{v_1}{\hat{\pi}}$, then $k^*(\hat{\pi}) < \frac{v_1}{\hat{\pi}}$.

Proof: See Appendix.

Part (a) tells us that the experiment elicits the true amount $k^*(\hat{\pi})$ that, given beliefs $\hat{\pi}$, makes individuals indifferent between $k^*(\hat{\pi})$ payable in period 2 and v_1 payable in period 1. Part (b) tells us that for any concave and increasing function $u(c)$, cutoffs fall with belief in the status quo, and there is a one-to-one mapping between the chosen beliefs and the chosen cutoff once the cutoff rises above v_1 . Part (c) suggests that an agents with full faith in the Rapture will have an unbounded cutoff. Intuitively, if the agent has a chosen belief that implies that the status quo will never occur, there is no consumption amount in period 2 that can compensate the agent for receiving v_1 in period 1. In the special case of risk neutrality, part (d) notes that the chosen cutoff is inversely proportional to $\hat{\pi}$ by a factor of $\frac{1}{v_1}$, implying that beliefs can be directly inferred from the cutoff. Part (e) states that, if individuals are risk averse, and have wealth larger than $\frac{v_1}{\hat{\pi}}$ (or, concretely for our experiment, larger than \$500), then the implied belief in the Rapture by a given cutoff will be larger than that by a risk neutral person. In other words, the beliefs we back out for a risk neutral person will if anything underestimate faith by the risk averse.

3.2.4 Belief choices

Thus far we have established that chosen beliefs can be elicited, but have not yet shown whether an experimental manipulation can induce changes in them. Now consider the problem of an agent who must choose her beliefs before the uncertainty in the experiment is resolved, and thus must anticipate the current and future financial implications of her own

behavior.¹⁵ Formally, the agent chooses $\hat{\pi}$ to maximize:

$$(1 - q) \{u(m - a(\hat{\pi})) + \pi u(a(\hat{\pi}))\} + \tag{4}$$

$$+ q \left\{ \begin{aligned} & F(k(\hat{\pi})) [u(m + v_1 - a(\hat{\pi}, v_1, 0)) + \pi u(a(\hat{\pi}, v_1, 0))] + \\ & + \int_{k(\hat{\pi})}^{\infty} [u(m - a(\hat{\pi}, 0, v_2)) + \pi u(a(\hat{\pi}, 0, v_2) + v_2)] f(v_2) dv_2 \end{aligned} \right\} \\ + (1 - \pi)U_r(\hat{\pi}) \tag{5}$$

As in the basic model, it is easy to show that the agent will either choose $\hat{\pi} = \pi$ or $\hat{\pi} = 0$. As before, the agent might choose $\hat{\pi} = 0$ in order to receive a spiritual payment in the state of the Rapture, even though this might distort savings decisions. However, if a positive $\hat{\pi}$ is chosen, the agent will not receive a spiritual payment and therefore desires no distortions in the cutoff and savings decisions, leading to a choice of $\hat{\pi} = \pi$. Given this binary decision, we can now establish a result analogous to that in Lemma 1: there exists a type π' that separates believers from skeptics. The primary addition is that 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 $\pi'(q) \in (0, 1)$ such that all types $\pi \leq \pi'(q)$ choose to fully believe in the Rapture and all types $\pi > \pi'(q)$ choose to remain skeptics (that is, they retain their priors).

b) (Short run elasticity of the demand for beliefs.) Consider $\tilde{q} > q$. Then $\pi'(\tilde{q}) < \pi'(q)$.

Proof: See appendix.

The results preceding this proposition had established that our experimental intervention would allow us to detect the presence of full believers in the Rapture and, more generally, obtain cutoffs that track sincerely held beliefs without affecting the belief choice of skeptics. The last proposition tells us that under our experimental intervention there still is a highest type that chooses to believe in the Rapture and that the manipulation of the parameter q (the probability that the BDM mechanism is implemented) should affect the measure of types who find it optimal to choose a full belief, without affecting the choice of full belief by those with inframarginal priors. The intuition is that an increase in the probability that the experiment is implemented raises the implicit price of holding extreme beliefs. For someone who chose to be a full believer but is close to the margin, an increase in price switches the order of the payoffs from fully believing and remaining skeptical, prompting a switch to

¹⁵We model the savings decision as following the experimental intervention in order not to have our results depend on an impossibility of subjects to make posterior adjustments in savings. A model that inverts the timing of savings and participation in the experiment yields similar results.

skepticism. In other words, part b) of the last proposition tells us that the experimental manipulation can inform us on the short run elasticity of the aggregate demand for beliefs.¹⁶ Note that empirically identifying the elasticity of the demand for beliefs requires a sample of people that contain types between the indifferent types $\pi'(q)$ for each of the two values of q that we used in the experiment. We return to this issue when presenting the empirical results.

Before turning to the experiment, it is worth emphasizing the central aspect of the mechanism we propose by reference to the model. As can be seen in the objective in (4), the payment v_2 looms as large as the agent’s beliefs $\hat{\pi}$ make it. This is because conditional on the experiment being implemented, the payment v_2 will be forthcoming if and only the period 2 comes to pass. This feature of our approach is crucial to eliciting true beliefs. Apocalyptic beliefs are costly in the experiment only because these beliefs are defined over a proposition that, come period 2, can be proved or disproved, triggering differential financial consequences in each case.

4 The Experiment

We designed an experiment to elicit both beliefs in Harold Camping’s Judgment Day prophecy that the “End of the World” would occur on May 21st, 2011, and to study the elasticity of those beliefs to 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 money payable by check in four weeks (a future date intentionally set post-May 21) and \$5 payable by check immediately. As noted, Camping’s theory implies—and FR members professed to believe—that money would be useless after May 21st. Therefore, the higher the belief in the prophecy, the higher the later payment required to maintain indifference. For example, a risk-neutral person with no pure time preference and a 50% belief in the prophecy would require \$10 post-May 21 to be indifferent with \$5 before May 21st, while the same person assigning an 80% probability to the prophecy being true would require \$25 post-May 21 instead. Thus, under the assumption that pure time preference and risk aversion are constant across the FR and SDA groups, and that the latter make choices driven by time preference only, we can estimate the beliefs held by the FR members and determine if they match their non-incentivized belief declarations.

¹⁶We emphasize the short run aspect for the following reason. In our theory optimization is instantaneous and any change in parameters prompts instantaneous adjustment. However, it is conceivable that psychological frictions (e.g., cognitive dissonance) may prevent instantaneous adjustment. Individuals may have to be exposed to changes in perceived costs for some time before they adjust. Thus, it is possible that changes in costs trigger changes in the long run even when the short run features less elastic responses.

Before discussing the elicitation of the elasticity of the belief, it is useful to discuss how beliefs might change with its “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. Our experiment, as framed by the model presented in Section 3, is premised on the idea that people optimally 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 undersaving relative to what the prior probabilities would warrant, which creates a cost in terms of expected utility. One can imagine that if the cost in terms of suboptimal financial decisions becomes more likely, fewer individuals may decide to forgo the full belief.

In order to experimentally vary the cost of suboptimal beliefs without changing the monetary payoffs in the BDM scheme, we randomly assigned participants into two treatment conditions which corresponded to different probabilities that the participant’s payment would be tied to their 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 value of future payments while staying within our experimental budget. This variation defined the two treatment *conditions* in our experiment. Note that the cost to a participant of a chosen belief increases with this probability, allowing us to test for a non-zero price elasticity of belief.

The experiment was run with two distinct subject *groups*: FR members and SDA members, which yields a 2x2 *group-condition* matrix.¹⁷ As discussed above, SDA members hold beliefs similar to those of FR members concerning the existence of the Judgment Day and the Rapture, except that SDA members do not claim to know the precise date. We use the SDA sample to see whether otherwise similar 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 to understand the experimental decision, or due to a lack of trust in us as experimenters to deliver on promised future payments.

¹⁷Henceforth, the term *group* refers to FR or SDA subjects, and the term *condition* refers to the 50% or the 6% treatment intensities.

4.1 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).¹⁸

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.¹⁹

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 the hardcore members of the group.

4.2 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.²⁰ 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

¹⁸We 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. We estimate that both the Family Radio Bible study meetings and the SDA service were attended by about 100 adults each.

¹⁹The donation to the organization helped us garner approval from the organizers of each group.

²⁰About half of the subjects declined to participate after reading the consent form. Decision packets for the 50% treatment from both groups are included in the online appendix at faculty.nps.edu/jcunha/research/faith_appendix.html; the 6% packet is identical up to the stated probability.

would be the Judgment 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 Judgment 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 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).²¹ 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 as described below. Depending on the participant's previous decision, the subject was either written a present-dated check for five dollars or a four-week-post-dated check for the payoff amount. 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.^{22,23} Figure 2 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. If they preferred \$5 today instead of any of the amounts in four weeks, they they were instructed to circle a box stating “I prefer \$5 today.” As expected, some

²¹In 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.

²²Our 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.

²³Amounts 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 2: 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.

subjects did not immediately understand the BDM method and were thus 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 receive \$5 today.” We refer to the smallest amount circled as the “cutoff” amount. If the subject did not circle any amounts, we confirmed that they had a cutoff of greater than \$500. Conditional on choosing a \$5 cutoff and having the random ball draw implemented, the expected value of playing the game was \$79.

4.3 Participant Overview and Summary Statistics

We surveyed 27 FR members and 29 SDA members. Of the 27 FR, four were excluded before analyzing the data. We excluded a mother and daughter pair, as we observed 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.²⁴ Thus, our analytical sample contains 23 FR and 29 SDA subjects.

Table 1 contains summary statistics for both the FR (columns 1 and 2) and SDA (columns 3 and 4) samples, split by treatment group and condition. Columns 3 and 6 contain p-values of tests of equality across treatment conditions. No observable characteristics are significantly different across treatment groups, 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. 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 Judgment, despite the fact that 80% had heard about Harold Camping’s prophecy. Figure 3 contains the empirical distribution of these beliefs for both samples: the beliefs are extreme in that very few subjects in either condition hold interior beliefs, in line with the theoretical predictions of our model.²⁵

Subjects from both groups expressed uncertainty about whether they would be Raptured on Judgment 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 man 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 Judgment 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 Judgment Day happening within their lifetime, with an average of about 40% probability. This is further evidence that large, closer to

²⁴It 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.

²⁵Strictly speaking, our model does not predict that skeptics will have a zero belief in the Rapture, unless we assume the priors for most people were indeed $\pi = 0$. That is, that life would surely go on as usual after May 21st.

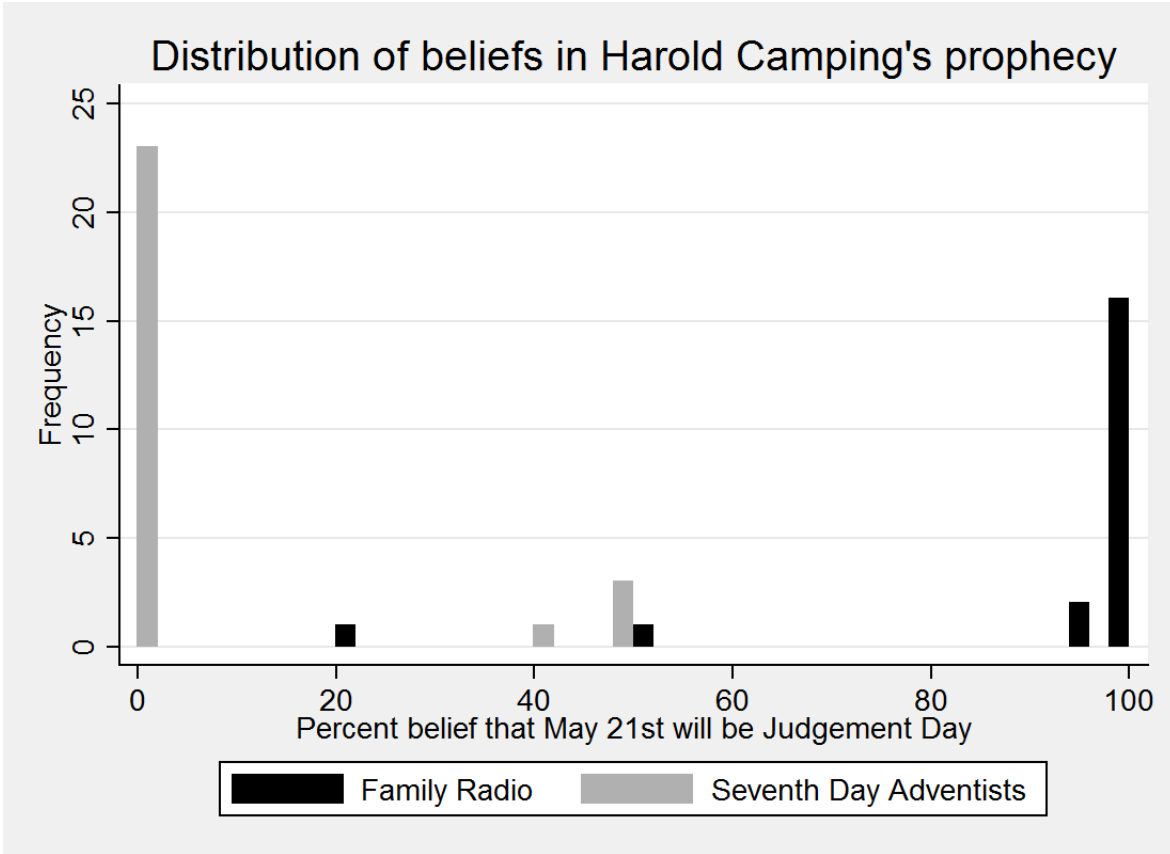


Figure 3: Histogram of stated beliefs in the prophecy, for both experimental samples.

mainstream, religious groups such as the SDA hold what many would consider “extreme” beliefs. The question “What is life going to be like on Earth after Judgment Day?” yielded strikingly similar responses from both samples, centering on destruction, chaos, and suffering.

4.4 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 for \$5 today—for each of the FR and SDA samples, separating the 6% and 50% conditions. The FR and SDA groups have separated towards 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. The table also shows that the average cutoff for SDA subjects was about \$20 and the median was \$7. In other words, SDA members chose to delay

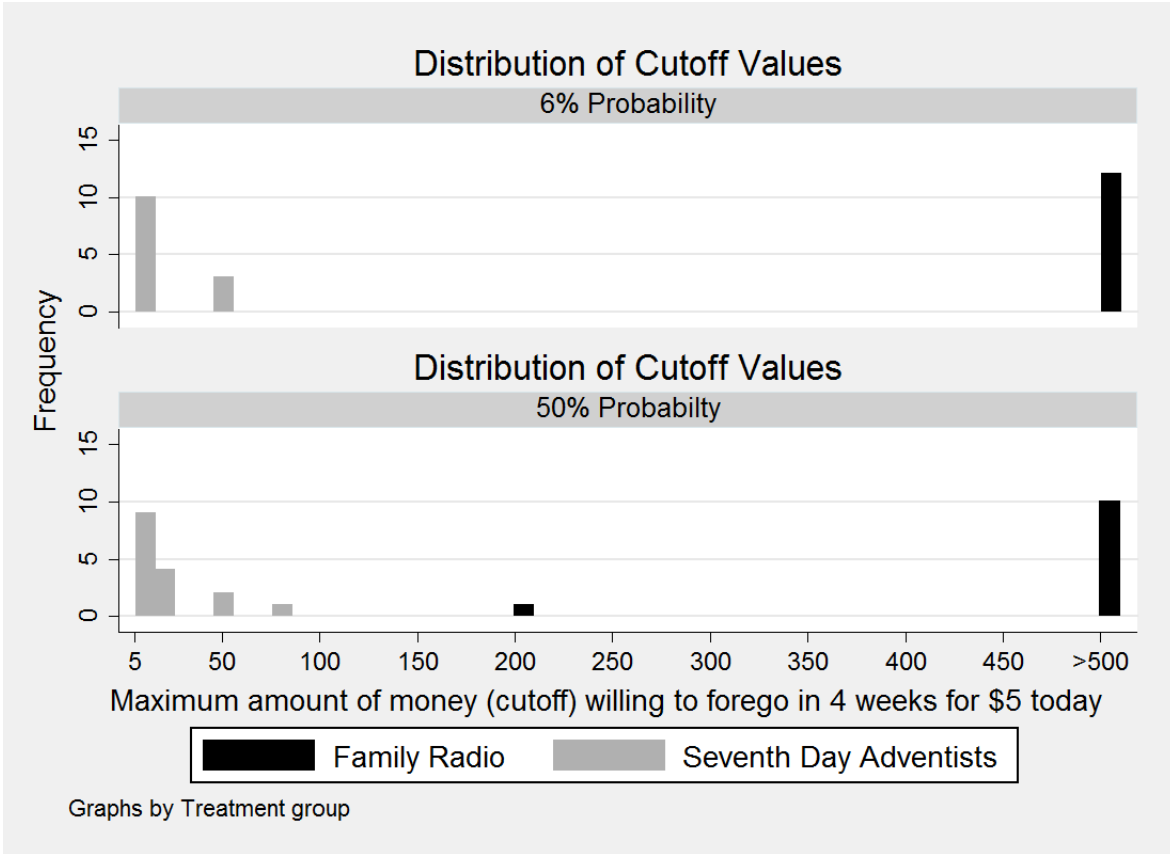


Figure 4: Histogram of cutoff values by treatment condition, for both experimental samples.

payment for a “reasonable” time-discount. Thus, the median discount (+ storage) factor one month out was $5/7 = 0.71$, which lies within the range of values found by laboratory studies (Frederick, Loewenstein, and O’Donoghue 2002). In contrast, FR members chose very large cutoffs: *only one subject chose a cutoff less than \$500* (specifically, a \$200 cutoff; the median cutoff among FR subjects is \$500, and the average \$487).

What do the cutoffs chosen by FR members imply in terms of the strength of their beliefs in the Rapture? We now make a simple calculation to provide a lower bound for the strength of the implied beliefs. In the case of risk neutrality, the indifference condition between a payment of \$5 today and a payment of \$ v in a month time is $5 = \delta p v$, where δ is a pure time preference discount factor and $1 - p$ is the belief in the Rapture. We now make two assumptions. One is that δ is common across groups and that the only driver of differential cutoffs is a varying belief p . Next, we assume we can use the median SDA discount factor, which matches previous estimates of time preference, to approximate the common parameter δ . (This is conservative: note that if SDA cutoffs reflected some belief

in the Rapture it would mean the SDA subjects are even more patient, which would lead to even higher estimates of the belief in the Rapture held by FR members.) Thus, if we take the median cutoff for the FR members (equal to \$500), the implied lower bound on the belief in the Rapture is $1 - p = 1 - \frac{5}{\delta V} = 98.6\%$. If we take the average cutoff for the FR members (equal to \$487), the implied lower bound for belief in the Rapture is virtually identical: 98.56%. This is consistent with the unincentivized question in the survey, where FR members expressed certainty about the Rapture.²⁶

The fact that the cutoffs chosen by SDA members are compatible with previous estimates of time preference provide reassurance that the cutoffs chosen by the FR members were not an artifact, but instead that they do reflect strong and *sincere* beliefs in the May 21st prophecy.

As made clear in Figure 4 is that 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 mean differences in cutoffs across conditions for each group, as well as non-parametric p-values. There are no significant differences across conditions for either group.

4.5 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 will face different intertemporal tradeoffs and thus should select different cutoffs k^* 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. By virtue of Proposition 1, the fact that by choosing a cutoff of \$500 the FR members forgo the possibility of earning up to \$500 dollars after the Rapture in exchange for \$5 immediately 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 in the FR subjects. In other words, a demand for beliefs appears to exist.

The fact that cutoffs are not significantly different across conditions for the SDA members

²⁶As stated in part e) of Proposition 1, the beliefs in the Rapture computed for a risk neutral person are a lower bound for the beliefs held if the person were risk averse.

is compatible with the idea that they do not have a demand for beliefs in the Rapture—they match the skeptics in our model, who do not respond to changes in the price of beliefs q . In addition, we find no evidence of an elastic aggregate demand for beliefs as defined by changes in the marginal believer. Evidence of elasticity 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. One explanation for the lack of evidence of elasticity is just that the demand for beliefs is inelastic in the short run—internalizing a new incentive structure may take time. Another explanation is that the small number of FR subjects we encountered had priors relatively far away from the marginal type π' ($q = 0.06$), 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.

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 Judgment 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.

4.6 Epilogue: Adjusting to the Prophecy Failure

We noted earlier that the vast majority of members of Family Radio 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 they react?

After May 21st it became extremely difficult to directly contact Family Radio members.²⁷ 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.²⁸ 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

²⁷Our 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.

²⁸The forum, with all posted messages, is located at http://groups.yahoo.com/group/TimeandJudgment_May212011/.

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 revealed an anxiety for 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 date, a new revision was immediately suggested and the group coalesced on that date. This active revision of the prediction with dates very close to May 21st continued until about the time Camping made his announcement on May 23rd that "spiritual judgment" had occurred indeed.

It is interesting to note this re-setting of dates after a failed prophecy is in fact typical for apocalyptic groups (Kyle 1998). For example, following the Millerites failed prophecy in 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.²⁹

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.

²⁹The other main faction, which went on to become the Seventh Day Adventists, found scriptural evidence against date setting but continues to believe Judgment Day is near.

5 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 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). Empirically disentangling the causal links between economic fundamentals, conversion motivated by direct economic interest versus true beliefs, as well as the possibility that economic interest leads to the development of sincere beliefs, requires an approach to measuring beliefs, which is what we provide.

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.^{30,31} While 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). Whether this proposition is true or the opposite holds (rather, beliefs drive religious activity) cannot be empirically evaluated without an approach to the direct measurement of beliefs like the one we propose.

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 model explicitly the manipulation of beliefs by tracking how they affect expected utility through separate channels: as probability weights in the

³⁰A 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.

³¹Palacios-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.

expected utility function and as arguments of a state-contingent utility function that gives beliefs instrumental value.

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 (2008)).

Moving on to the empirics of distorted beliefs, we are not aware of experimental studies attempting to establish the presence of a “demand for beliefs,” although behavioral economists have identified ways in which subjective beliefs depart from Bayesian posteriors. 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 hardwired processing bias toward the positive.³² 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).

6 Conclusion

Understanding faith, that is, strong beliefs that are by definition not driven by evidence, is an important pending assignment of the economics of religion, and it may yield insights into decision-making more broadly. In this paper, we study the demand for beliefs through the prism afforded by a recent apocalyptic movement which gave us the rare opportunity to use standard experimental techniques to measure beliefs about a falsifiable religious proposition. Specifically, we performed an incentivized, relatively high-stakes, time-preference experiment relying on the members of Harold Camping’s Family Radio group, who expected Judgment

³²For example, Balci and Dunning (2006) document biases occurring in visual perception with very short (30-100ms) decision time frames.

Day to occur on May 21st, 2011.

Our experiment is framed by a theoretical model that highlights how the experimental approach elicits religious beliefs when these are defined over falsifiable propositions. While our model is parsimonious and works on the logic of the Pascalian wager, it can be extended to incorporate a richer set of psychological motives, such as those of anticipation. The key aspect of the model is that it allows for consistent (i.e., rational) manipulation of beliefs once these enter as arguments in some state-contingent utility. Our model predicts manipulation of beliefs to full religious belief for a certain set of priors. It also explains how the experimental intervention could both establish the presence of a demand for beliefs and yield estimates of the elasticity of that demand.

The evidence indicates the existence of a sincere belief in the end of the world, which rules out both evidence-based beliefs and that the Family Radio members external profession of beliefs was being driven by exclusively social motives. 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. A clear line for future research is to apply these experimental methods to other falsifiable religious statements (such as the effect of prayer on sickness) with larger sample sizes and potentially larger incentives (for example, our results might have been more enlightening with an upper payment higher than \$500).

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 is grossly unwarranted based on available evidence. But this may in fact be a habit affecting all of us to varying degrees. A review of the historical record establishes that apocalyptic themes are central to nearly all major world religions, which involve many other articles of faith. And another interesting parallel can be drawn with the way in which the Family Radio followers reacted to the failure of the prophecy. A large share of the members admitted that secondary aspects of the prophecy, such as the precise date or the visibility of Judgment could have been wrong, but that the central beliefs in the Judgment and in God more generally were surely right. This is not dissimilar to Lakatos' description of how science might reasonably work, namely by creating a core of central propositions and a protective belt of auxiliary predictions, which if disproven would not imply disproving the core.

Thus, a promising area for future research involves the question of what are the standards of proof that individuals are willing to accept to test their beliefs. Another avenue involves further theory and empirics on the possible tradeoffs between beliefs and incentives. Lastly, in light of our results, it would be important to enrich the market analysis of religion with models where the demand side includes sincere faith as an active component.

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7 Appendix A: Theory

Proof of Lemma 1: Note that the payoff from choosing $\hat{\pi} = \pi$ and $\hat{\pi} = 0$ are the same if $\pi = 0$. Therefore, consider $\pi \in (0, 1]$. Define $\Phi(\pi) \equiv u(m - a(\pi)) + \pi u(a(\pi))$, the payoff to

the agent from choosing $\hat{\pi} = \pi$. Define $\Psi(\pi) \equiv u(m) + (1 - \pi)u_r$, the payoff from choosing $\hat{\pi} = 0$. Note that both $\Phi(\pi)$ and $\Psi(\pi)$ are continuous. Using the Envelope Theorem, it is easy to see that $\Phi'(\pi) = u(a(\pi))$, so $\Phi(\pi)$ must be an increasing function. As $\Psi'(\pi) = -u_r$, $\Psi(\pi)$ is a decreasing function. It is easy to see that $\Phi(1) = 2u\left(\frac{m}{2}\right)$ and $\Psi(1) = u(m)$ and $\Phi(\pi) \rightarrow u(m)$ and $\Psi(\pi) \rightarrow u(m) + u_r$ as $\pi \rightarrow 0$. Note that $\Psi(\pi) > \Phi(\pi)$ as $\pi \rightarrow 0$ and $\Psi(1) < \Phi(1)$ as $2u\left(\frac{m}{2}\right) > u(m)$ for any concave $u(\cdot)$. Thus, there exists a unique, interior type $\pi' \in (0, 1]$ such that $\Phi(\pi') = \Psi(\pi')$ and $\Phi(\pi) > \Psi(\pi)$ for $\pi > \pi'$ and $\Phi(\pi) < \Psi(\pi)$ for $\pi < \pi'$. Therefore, all types with priors $\pi \leq \pi'$ will choose to fully believe, while those with priors above π' retain their priors. ■

Proof of Proposition 1:

a) Consider the first order condition of objective function in equation 2 with respect to k :

$$f(k) [u(m + v_1 - a(\hat{\pi}, v_1, 0)) + \hat{\pi}u(a(\hat{\pi}, v_1, 0))] = f(k) [u(m - a(\hat{\pi}, 0, k)) + \hat{\pi}u(a(\hat{\pi}, 0, k) + k)]$$

This leads directly to the result as $f(k)$ cancels.

b) Showing the cutoff k^* is decreasing in $\hat{\pi}$ relies on the intuition that an individual with a lower belief in the world continuing must demand more money in period 2 to remain indifferent after a loss of money today. So, we will consider consider $\hat{\pi}_1 > \hat{\pi}_2$ and will show that this implies that $k(\hat{\pi}_1) \leq k(\hat{\pi}_2)$. Recall that $k \in [v_1, \infty)$. There are two mutually exclusive and exhaustive situations that we will explore. In the first, we have $k(\hat{\pi}_1) = v_1$. Then, $k(\hat{\pi}_1) \leq k(\hat{\pi}_2)$ follows trivially as $v_1 \leq k(\hat{\pi}_2)$ by definition. In the second, we have $k(\hat{\pi}_1) > v_1$. We will show that this implies that $\frac{dk(\hat{\pi})}{d\hat{\pi}} < 0$, noting this implies that $k(\hat{\pi}_1) \leq k(\hat{\pi}_2)$. Differentiating the implicit function $k^*(\hat{\pi})$ with respect to $\hat{\pi}$ and using envelope theorem, we get:

$$\frac{dk}{d\hat{\pi}} = \frac{u(a(\hat{\pi}, v_1, 0)) - u(a(\hat{\pi}, 0, k(\hat{\pi})) + k(\hat{\pi}))}{\hat{\pi}u'(a(\hat{\pi}, 0, k(\hat{\pi})) + k(\hat{\pi}))}$$

As $\hat{\pi}u'(a(\hat{\pi}, 0, k(\hat{\pi})) + k(\hat{\pi})) > 0$, $\frac{dk}{d\hat{\pi}} < 0$ if and only if:

$$u(a(\hat{\pi}, v_1, 0)) - u(a(\hat{\pi}, 0, k(\hat{\pi})) + k(\hat{\pi})) < 0. \tag{6}$$

To see this inequality is true, we will establish two claims. First we will prove *claim (i)*, namely that an individual with a cutoff $k^* > v_1$ must be saving very little (some amount $\alpha < v_1$). Then we will show *claim (ii)*, namely that such an individual will choose zero savings $a = 0$ if the experiment delivers an amount $v_2 \geq v_1$ in the second period. Those two statements together will render the inequality in (6) equal to $u(\alpha) - u(k(\hat{\pi}_1)) < 0$, which must be true since by assumption $k(\hat{\pi}_1) > v_1$ and from claim (i) $\alpha < v_1$.

Claim (i): If $k(\hat{\pi}_1) > v_1$, then $a(\hat{\pi}_1, v, 0) < v_1$.

Suppose for the sake of contradiction that $a(\hat{\pi}_1, v_1, 0) \geq v_1$, and define $\phi \equiv a(\hat{\pi}_1, v_1, 0) - v_1 \geq 0$. Then the individual receiving v_1 in the first period saves all of that amount and potentially some additional amount ϕ of the original endowment m . Recall the optimal saving decision $a(\hat{\pi}_1, v_1, 0)$ maximizes $u(m + v_1 - a) + \hat{\pi}_1 u(a)$, or, equivalently, that ϕ maximizes $u(m - \phi) + \hat{\pi}_1 u(\phi + v_1)$. Now suppose a transfer v_1 were promised for period 2, leading the agent to choose $a(\hat{\pi}_1, 0, v_1)$ to maximize $u(m - a) + \hat{\pi}_1 u(a + v_1)$, which is identical to the problem of choosing ϕ . Therefore, $a(\hat{\pi}_1, 0, v_1) = \phi$. Thus, $a(\hat{\pi}_1, 0, v_1) = a(\hat{\pi}_1, v_1, 0) - v_1$, which implies that $a(\hat{\pi}_1, v_1, 0) = a(\hat{\pi}_1, 0, v_1) + v_1$ and $m - a(\hat{\pi}_1, v_1, 0) + v_1 = m - a(\hat{\pi}_1, 0, v_1)$ and so it must be that:

$$u(m - a(\hat{\pi}, v_1, 0) + v_1) + \hat{\pi}u(a(\hat{\pi}, v_1, 0)) = u(m - a(\hat{\pi}, 0, v_1)) + \hat{\pi}u(a(\hat{\pi}, 0, v_1) + v_1).$$

But then $k(\hat{\pi}_1) = v_1$ by the implicit equation that defines k in Proposition 1, yielding a contradiction with the premise that $k(\hat{\pi}_1) > v_1$ and we must have that $a(\hat{\pi}_1, v, 0) < v_1$, substantiating claim (i).

Claim (ii): $a(\hat{\pi}, 0, x) = 0$ for any $x > v_1$.

Given the optimality of a , we know that $u'(m - a(\hat{\pi}, v_1, 0) + v_1) = \hat{\pi}u'(a(\hat{\pi}, v_1, 0))$. Note that $u'(m) \geq u'(m - a(\hat{\pi}, v_1, 0) + v_1)$ as $v_1 - a(\hat{\pi}, v_1, 0) > 0$ (from claim (i)), and that $\hat{\pi}u'(a(\hat{\pi}, v_1, 0)) \geq \hat{\pi}u'(x)$ as $x > v_1 > a(\hat{\pi}, v_1, 0)$. By transitivity, $u'(m) \geq \hat{\pi}u'(x)$, and the expression $u(m - a(\hat{\pi}, 0, x)) + \hat{\pi}u(x + a(\hat{\pi}, 0, x))$ must be maximized at $a(\hat{\pi}, 0, x) = 0$.

Therefore, Equation 6 must be true and therefore $\frac{dk(\hat{\pi})}{d\hat{\pi}} < 0$ if $k(\hat{\pi}_1) > v_1$ and therefore $k(\hat{\pi}_1) \leq k(\hat{\pi}_2)$ if $k(\hat{\pi}_1) > v_1$.

c) To show that $k(\hat{\pi}) \rightarrow \infty$ as $\hat{\pi} \rightarrow 0$, We will show that for any cutoff \bar{k} , there exists some belief $\epsilon > 0$ such that $k^*(\epsilon) > \bar{k}$. It is easy to show that savings must approach zero as the probability of consumption in period 2 drops to zero: $\hat{\pi} \rightarrow 0 \Rightarrow a(\hat{\pi}, \cdot, \cdot) \rightarrow 0$. Therefore, as $\hat{\pi} \rightarrow 0$, $u(m - a(\hat{\pi}, 0, \bar{k})) + \hat{\pi}u(a(\hat{\pi}, 0, \bar{k}) + \bar{k}) \rightarrow u(m)$ and $u(m + v_1 - a(\hat{\pi}, v_1, 0)) + \hat{\pi}u(a(\hat{\pi}, v_1, 0)) \rightarrow u(m + v_1)$. Therefore, given the continuity of these functions, there must exist an ϵ such that $u(m + v_1 - a(\epsilon, v_1, 0)) + \epsilon u(a(\epsilon, v_1, 0)) > u(m - a(\epsilon, 0, \bar{k})) + \epsilon u(a(\epsilon, 0, \bar{k}) + \bar{k})$. Note that for a given $\hat{\pi} > 0$, $u(m - a(\hat{\pi}, 0, k)) + \hat{\pi}u(a(\hat{\pi}, 0, k) + k)$ is monotonically increasing and unbounded in k . Therefore, there exists $k^*(\epsilon) > \bar{k}$ such that $u(m + v_1 - a(\epsilon, v_1, 0)) + \epsilon u(a(\epsilon, v_1, 0)) = u(m - a(\epsilon, 0, k^*(\epsilon))) + \epsilon u(a(\epsilon, 0, k^*(\epsilon)) + k^*(\epsilon))$.

d) Consider $u(c) = c$ and $\hat{\pi} \in (0, 1]$. Then $a(\hat{\pi}, v, 0) = \arg \max \{ u(m + v_1 - a) + \hat{\pi}u(a) \}$, which is equal to $\arg \max \{ m + v_1 - a + \hat{\pi} \cdot a \}$, and $a(\hat{\pi}, 0, k) = \arg \max \{ u(m - a) + \hat{\pi}u(a + k) \} = \arg \max \{ m - a + \hat{\pi} \cdot (k + a) \}$. We now consider two cases. If $\hat{\pi} = 1$, the player is indifferent between all possible choices of a , and then $k^* = \frac{v}{\hat{\pi}} = v$ as $m + v - a + 1 \cdot a = m - a + 1 \cdot (v + a)$ for any a . If $\hat{\pi} \in (0, 1)$, $a(\hat{\pi}, v_1, 0) = 0$ and $a(\hat{\pi}, 0, k) = 0$, yielding $k^* = \frac{v_1}{\hat{\pi}}$

as $m + v_1 = m + \hat{\pi}(k^*)$ by the definition of k^* .

e) A risk averse person will have a lower belief in the status quo conditional on a given cutoff if $k^*(\hat{\pi}) < \frac{v_1}{\hat{\pi}}$. Using the fact that $k^* \geq v$ implies $a(\hat{\pi}, 0, k^*) = 0$, the implicit equation characterizing k^* in part a) is $u(m + v - a(\hat{\pi}, v, 0)) + \hat{\pi}u(a(\hat{\pi}, v, 0)) = u(m) + \hat{\pi}u(k^*)$. Writing $a(\hat{\pi}, v, 0) = a$ for simplicity, that equation implies that what we need to prove is that if $\frac{v}{\pi} < m$, then $u(m + v - a) - u(m) < \pi(u(\frac{v}{\pi}) - u(a))$. This inequality yields $\int_m^{m+v-a} u'(c)dc < \int_a^{\frac{v}{\pi}} \pi u'(c)dc$. Given a generic function $\int_{x_1}^{x_2} f(x)dx$, it is easy to see that if $f'(x) < 0$ then $(x_2 - x_1)f(x_2) < \int_{x_1}^{x_2} f(x)dx < (x_2 - x_1)f(x_1)$. Then, concavity of $u(c)$ implies $\int_m^{m+v-a} u'(c)dc < (v - a)u'(m)$ and also $\int_a^{\frac{v}{\pi}} \pi u'(c)dc > (\frac{v}{\pi} - a)\pi u'(\frac{v}{\pi})$, and then $(v - a)u'(m) < (v - a)u'(\frac{v}{\pi}) < (\frac{v}{\pi} - a)\pi u'(\frac{v}{\pi})$ (the first inequality follows from the fact that $u'(m) < u'(\frac{v}{\pi})$ as $m > \frac{v}{\pi}$, and the second from the fact that $v - a < (\frac{v}{\pi} - a)\pi$). Then we get $\int_m^{m+v-a} u'(c)dc < \int_a^{\frac{v}{\pi}} \pi u'(c)dc$, completing the proof. ■

Proof of Proposition 2:

a) Note that the payoff from choosing $\hat{\pi} = \pi$ and $\hat{\pi} = 0$ are the same if $\pi = 0$. Therefore, consider $\pi \in (0, 1]$. If choosing a full belief $\hat{\pi} = 0$, then k is unbounded and a is always 0. Therefore, the agent receives

$$\Psi(\pi, q) = (1 - q)u(m) + qu(m + v_1) + (1 - \pi)u_r, \quad (7)$$

and if he keeps his prior, the agent gets the payoff in (4) evaluated at $\hat{\pi} = \pi$:

$$\begin{aligned} \Phi(\pi, q) &= (1 - q)[u(m - a(\pi, 0, 0)) + \pi u(a(\pi, 0, 0))] & (8) \\ &+ q \left[\begin{aligned} &F(k(\pi))[u(m + v_1 - a(\pi, v_1, 0)) + \pi u(a(\pi, v_1, 0))] \\ &+ \int_{k(\pi)}^{\infty} [u(m - a(\pi, 0, v_2)) + \pi u(a(\pi, 0, v_2) + v_2)] f(v_2) dv_2 \end{aligned} \right]. & (9) \end{aligned}$$

Therefore, using (7) and (8), the agent chooses $\hat{\pi} = 0$ or $\hat{\pi} = \pi$ depending on the comparison of these payoffs. Note that both of these functions are continuous. Using the Envelope Theorem, $\frac{\partial \Phi(\pi, q)}{\partial \pi} = (1 - q)u'(a(\pi)) + F(k(\pi))u'(a(\pi, v_1, 0)) + \int_{k(\pi)}^{\infty} [u'(a(\pi, 0, v_2) + v_2)] f(v_2) dv_2$. All of these components are positive, so $\Phi(\pi, q)$ must be increasing in π . As $\frac{\partial \Psi(\pi, q)}{\partial \pi} = -u_r$, Ψ is a decreasing function in π . As $k(1) = v_1$, note that $\Phi(1, q) = (1 - q)2u(\frac{m}{2}) + q \left[\int_{v_1}^{\infty} [u(m - a(1, 0, v_2)) + u(a(1, 0, v_2) + v_2)] f(v_2) dv_2 \right]$ and $\Psi(1, q) = (1 - q)u(m) + qu(m + v_1)$. As $k(\pi) \rightarrow \infty$ as $\pi \rightarrow 0$, note that $\Phi(\pi, q) \rightarrow (1 - q)u(m) + qu(m + v_1)$ and $\Psi(\pi, q) \rightarrow (1 - q)u(m) + qu(m + v_1) + u_r$ as $\pi \rightarrow 0$. Note that $\Psi(\pi, q) > \Phi(\pi, q)$ as $\pi \rightarrow 0$ for any q and $\Psi(1, q) < \Phi(1, q)$ for any q (as $(1 - q)2u(\frac{m}{2}) > (1 - q)u(m)$ for any concave $u(\cdot)$ and $q(u(m - a(1, 0, v_2)) + u(a(1, 0, v_2) + v_2)) > qu(m + v_1)$ by the definition of k). Thus, there

exists a unique, interior type $\pi'(q) \in (0, 1]$ such that $\Phi(\pi', q) = \Psi(\pi', q)$ and $\Phi(\pi, q) > \Psi(\pi, q)$ for $\pi > \pi'(q)$ and $\Phi(\pi, q) < \Psi(\pi, q)$ for $\pi < \pi'(q)$. Therefore, all types with priors $\pi \leq \pi'(q)$ will choose to fully believe, while those with priors above $\pi'(q)$ retain their priors.

b) Now we analyze effect of q on the set of believers. Recall that $\pi'(q)$ is the type such that $\Phi(\pi', q) = \Psi(\pi', q)$. Our goal is to show that $\frac{\partial \pi'(q)}{\partial q} < 0$. To do this, we will show that $\frac{\partial \Phi(\pi, q)}{\partial q} > \frac{\partial \Psi(\pi, q)}{\partial q}$, as it then follows that an (small) increase from q_1 to q_2 increases the payoff from skepticism faster than the payoff from full belief and therefore $\Phi(\pi'(q_1), q_2) > \Psi(\pi'(q_1), q_2)$ and therefore $\pi'(q_2) < \pi'(q_1)$, implying that $\frac{\partial \pi'(q)}{\partial q} < 0$. To show that $\frac{\partial \Phi(\pi, q)}{\partial q} > \frac{\partial \Psi(\pi, q)}{\partial q}$, we proceed through six steps.

1. First, simply compute the two magnitudes:

$$\frac{\partial \Psi(\pi, q)}{\partial q} = u(m + v_1) - u(m)$$

and

$$\begin{aligned} \frac{\partial \Phi(\pi, q)}{\partial q} &= F(k(\pi)) [u(m + v_1 - a(\pi, v_1, 0)) + \pi u(a(\pi, v_1, 0))] \\ &\quad + \int_{k(\pi)}^{\infty} [u(m) + \pi u(v_2)] f(v_2) dv_2 \\ &\quad - [u(m - a(\pi, 0, 0)) + \pi u(a(\pi, 0, 0))]. \end{aligned}$$

(Henceforth, to shorten notation we write $a(\pi) \equiv a(\pi, 0, 0)$).

2. Note that,

$$\frac{\partial \Phi(\pi, q)}{\partial q} > u(m + v - a(\pi, v, 0)) + \pi u(a(\pi, v, 0)) - u(m - a(\pi)) - \pi u(a(\pi)) \equiv Y.$$

This follows from the fact that,

$$\left\{ \begin{array}{l} F(k(\pi)) [u(m + v_1 - a(\pi, v_1, 0)) + \pi u(a(\pi, v_1, 0))] \\ \quad + \int_{k(\pi)}^{\infty} [u(m) + \pi u(v_2)] f(v_2) dv_2 \end{array} \right\} > u(m + v - a(\pi, v, 0)) + \pi u(a(\pi, v, 0))$$

must hold from the definition of $k(\pi)$. Therefore, by transitivity, our proof would be complete if we could show that $Y > \frac{\partial \Psi(\pi, q)}{\partial q}$. The following four steps establish this inequality.

3. Let us rewrite Y as a sum of two terms,

$$\begin{aligned} Y &= u(m + v - a(\pi, v, 0)) - u(m - a(\pi)) + \pi [u(a(\pi, v, 0)) - u(a(\pi))] \\ &\equiv Y' + \pi [u(a(\pi, v, 0)) - u(a(\pi))], \end{aligned}$$

where $u(a(\pi, v, 0)) - u(a(\pi)) > 0$ since $u(a(\pi, v, 0))$ is increasing in v (savings increase with initial endowment).

4. Note that from concavity and the fact that $a(\pi) > 0$,

$$u(m + v - a(\pi)) - u(m - a(\pi)) > u(m + v) - u(m) = \frac{\partial \Psi(\pi, q)}{\partial q}.$$

Now adding and subtracting $u(m + v - a(\pi, v, 0))$ to the LHS of the latter inequality, we get,

$$Z \equiv u(m + v - a(\pi, v, 0)) + u(m + v - a(\pi)) - u(m - a(\pi)) - u(m + v - a(\pi, v, 0)) > \frac{\partial \Psi(\pi, q)}{\partial q}.$$

5. This step shows that $u(m + v - a(\pi)) - u(m + v - a(\pi, v, 0)) \leq \pi [u(a(\pi, v, 0)) - u(a(\pi))]$. To see this is true, simply rearrange it as

$$u(m + v - a(\pi)) + \pi u(a(\pi)) \leq u(m + v - a(\pi, v, 0)) + \pi u(a(\pi, v, 0)),$$

where the sign of the inequality follows from optimality of $a(\pi, v, 0)$ in a situation where the endowment is $m + v$.

6. The fourth step is to note that $Y \geq Z$,

$$\begin{aligned} Z &= u(m + v - a(\pi, v, 0)) - u(m - a(\pi)) + u(m + v - a(\pi)) - u(m + v - a(\pi, v, 0)) \\ &= Y' + u(m + v - a(\pi)) - u(m + v - a(\pi, v, 0)) \\ &\leq Y' + \pi [u(a(\pi, v, 0)) - u(a(\pi))] = Y, \end{aligned}$$

where the last inequality follows from using steps 3 and 5. Thus, invoking step 4, transitivity yields $Y \geq Z > \frac{\partial \Psi(\pi, q)}{\partial q}$, which completes the proof. ■

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

	Family Radio Sample			7 th Day Adventist Sample		
	6% Treatment (1)	50% Treatment (2)	p-value (1) = (2) (3)	6% Treatment (4)	50% Treatment (5)	p-value (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	

Notes:

(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 on May 21st; for these subjects we code this question as a 100% belief.

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

Panel A: Pooled conditions						
	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				

Panel B: Non-pooled conditions						
	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.