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Religion, Clubs, and Emergent Social Divides

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Abstract

Arguments for and against the existence of an American cultural divide are frequently placed in a religious context. This paper seeks to establish that, all politics aside, the American *religious* divide is real, that modern religious polarization is not a uniquely American phenomenon, and that religious divides can be understood as naturally emergent within the club theory of religion. Analysis of the 2005 Baylor University Religion Survey reveals a bimodal distribution of religious commitment in the United States. International survey data reveals evidence of bimodal distributions in all twenty-nine surveyed countries. The club theory of religion, when applied in a multi-agent model, generates bimodal distributions of religious commitment whose emergence correlates to the substitutability of club goods for standard goods and the mean population wage rate. This tendency towards religious polarization has important ramifications for majority rule electoral outcomes when religion is politically salient. Majority rule, principally analogous to the statistical median, is a non-robust estimator of bimodally distributed voter preferences.

Keywords. Culture Divide, Religious Divide, Club Theory, Multi-Agent Model, Sacrifice and Stigma

JEL Codes: C63, Z12, D71, D72

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"The interested and active zeal of religious teachers can be dangerous and troublesome only where there is either but one sect tolerated in the society, or where the whole of a large society is divided into two or three great sects;"

"In every civilized society, in every society where the distinction of ranks has once been completely established, there have been always two different schemes or systems of morality current at the same time; of which the one may be called the strict or austere; the other the liberal,…"

- Adam Smith, *The Wealth of Nations*, Book V, Chapter 1, Part 3. Article 3

1 Introduction

Beneath all contemporary claims of a U.S. cultural divide or "red vs. blue" states there lies the tension between the religious and the ostensibly secular. Motivating debates of cultural identity, religious adherence, and political affiliation is the question of whether the shared values identifiable with the opposing sides of the divide have become determining factors in democratic elections. Reconciling these debates is all the more difficult given that the *existence* of a cultural divide remains unresolved. Some argue for the existence of a salient, even acrimonious divide (Hunter 1991; Abramowitz and Saunders 2005), others against it (DiMaggio et al. 1996; Wolfe 1998; Fiorina et al. 2005; Ansolabehere et al. 2006). If a culture war is being fought, the battles are won and lost at the ballot box. Related research has followed from this logic, focusing on election results, exit polls, and surveys of political preferences. Researchers have given religion its due, but primarily in the context of how religious preferences manifest themselves politically.

This paper seeks to establish that, all politics aside, the American *religious* divide is real, that modern religious polarization is not a uniquely American phenomenon, and that religious divides can be understood as naturally emergent phenomena within the club theory of religion. Further, we argue that the natural emergence of religious polarization has important ramifications for electoral outcomes of majority rule democracy. We present analysis of two major religious surveys, finding evidence of religious divides in the United States and in 27 other countries (out of 30 surveyed) from around the world. The prevalence of religious divides opens the possibility for a theory wherein religious polarization is a standard outcome. We build a model of religious group membership in a heterogeneous population of utility maximizing agents using a multi-agent variation of the club theory of religion (Iannaccone 1992; Berman 2000; McBride 2007). Simulation testing of the model shows that a population of agents with a unimodal distribution of incomes consistently emerges a bimodal distribution of agents' commitment to their religious clubs. Model results suggest that the U.S. political landscape is less likely derivative of a historically novel cultural divide, but rather the result of a religious divide naturally emergent of religious clubs, membership requirements, and group identity.

The importance of the hypothesized divide and its impact on American electoral outcomes is uncertain. There is seemingly contradictory survey evidence that while religiosity dominates income in voter choice (Shapiro et al. 2005; Glaeser and Ward 2006), economic policy preferences, though weakening over time, still dominate moral preferences in voters' estimation of their own decision-making process (Ansolabehere, Rodden et al. 2006). One potential source of these seemingly contradictory findings may be the distributional shapes of moral and economic preferences, each indexed in a single dimension issue space, which, in the context of the median voter theorem, lead to potentially different responses from vote-maximizing politicians. In the classic Hotelling-Downs model, the unimodal distribution of voters' economic preferences should lead to strong convergence in the platforms of competing politicians (Fiorina 1999).[1] Ansolabehere et al find their index of religious and moral values, however, to be bimodally distributed across their survey respondents. When voters preferences in

[1] More specifically, according to Fiorina, it should lead to *intra-district* convergence in the economic platforms of competing candidates.

a single dimension issue space are bimodal, greater candidate platform divergence may follow (Calvert 1985; Holcombe 1989; Medoff et al. 1995).[2] Ansolabehere et al, however, take care to point out that their multi-peaked moral values distribution is consequent of the abortion issue; if we leave this issue out of the scale, the distribution takes on a more unimodal shape. While abortion is an inherently divisive issue on its own accord, given its strong connections to religious values (Evans et al. 2001), its impact on the distribution of survey responses might also reflect an underlying divide of broader significance. Separate religious subpopulations are relevant to the current political landscape, particularly in the context of a unimodal distribution of economic preferences. Under these conditions, politicians have incentive to converge rapidly to near identical positions on economic issues, while deviating from potentially "median" positions in both their official platform and coded messages concerning the two religious sub-populations. If this were in fact the case, it would reconcile the finding that religion has become more salient than income in voting decisions with the concurrent evidence that voters place greater weight on their economic preferences. Voters may care more about economic issues, but they are left with religiously informed issues as their means of differentiating between rival candidates.

The empirical observation of religious divides and their emergence with our club theoretic model of religious populations has important ramifications for the stability of electoral outcomes under majority rule. In statistical analysis, bimodal distributions have the peculiar property that the median is a less-robust estimator of central tendency than the mean. If we conceive of voter preferences as a one-dimensional continuum, the median of voter preferences will be considerably more influenced by small sample differences when the distribution is

[2] Most theories of divergence from the median voter theorem when preferences are bimodal rest on ideas of voter alienation and abstention. Other theories, however, find that bimodality can leave the median outcome unchanged, or lead to the absence of a stable strategy prediction (Davis et al. 1970).

bimodal. Levy (1989) identifies not just these statistical properties, but also the historical and philosophical contexts of bimodal voter preferences as explanations for faction, political violence, and the rise of tyranny. Under the bimodality scenario, small disturbances are more likely to generate large changes in election outcomes. According to Wand et al. (2002), the 2000 U.S. Presidential election was decided by just such a random error. The outcome resultant of this error was significantly different from the policy bundle preferred by the hypothetical median voter. The tendency for religious identities to polarize in the theoretic model and the empirical observation of religious polarization in the U.S. and the other countries suggest that similar events can be anticipated in majority rule elections when religious values supersede economic values in voter decision making.

2 The US Religious Divide

The hypothesized divide in American society fits in a variety of constructs: red states vs. blue states; religious vs. secular; rich vs. poor; north vs. south. Fiorina et al (2005) present a variety of survey results demonstrating that, despite the red/blue rhetoric, most states and regions comprise a good deal of political diversity. In their analysis, "purple states" would appear to be the norm. Even where there is evidence of a cultural gap, it is a relatively small gap compared to popular culture war hyperbole. Ansolabehere et al. (2006) support the Fiorina et al claim, with empirical evidence that voting preferences are a greater function of economic preferences, that there is remarkably narrow distribution of opinion over the range of "economic" issues, and that the distribution is single peaked. There does exists a divide over "moral" issues, and this may be the ulitmate source of the "red state – blue state" phenomenon, but they suggest this is likely both an accident of geography and an artifact of a single issue: abortion.

Neither of these research endeavors denies the heterogeneity of the American population and the opinions its constituents profess. Rather, each makes persistent efforts to refute the over-the-top claims of a divided nation whose members stand in stark opposition to one another. In light of this, Glaeser and Ward (2006) take pains to show that amongst the clutter of myths that is the cultural divide discussion, there are several empirical realities that have tremendous bearing on the political landscape. The population is indeed heterogeneous, with different states often representing distinctly different distributions of values over specific cultural topics. There are purple states, but they are neighbored by some that are very blue and others that are unquestionably red. Ansolabehere et al, while arguing for an undivided, purple America, take careful note of the greater saliency of a religious divide in American culture, noting that Protestants and non-Protestants differ by a full standard deviation on the scale of moral values, and Evangelical Protestants differ even more from the rest of the population.[3] Glaeser and Ward highlight strong state to state heterogeneity of surveyed responses to statements, several of which carry a strong religious connotation.[4] If there is a religious divide, however, then these differences of opinion are symptoms of that divide. What we want to know is whether there is fundamental bifurcation in the religious identity of the American population, with individuals pulled from distinctly separate religious distributions.

[3] More recent work does find some correlation between religious denomination and opinions on trade policy as well (Daniels and von der Ruhr 2005).

[4] Examples of such questions include "AIDS Might be God's Punishment for Immoral Sexual Behavior" [Agree/Disagree] and "We Will All be Called Before God on Judgment Day to Answer for Our Sins" [Agree/Disagree].

2.1 The Baylor Religion Survey

In 2005, researchers at Baylor University conducted a survey of 1,721 Americans, selected randomly from the population (Bader et al. 2006). The remarkable nuance of the survey allowed for calculations of time allotted to religious activities associated with congregations or groups by individual respondents. We use results from questions regarding time spent in religious services (mass), volunteering to their congregation, and religious service activities to create an approximation of time dedicated to their religious group during the last year (R_T^{Baylor}). Data regarding income and hours worked in the previous week were used to impute a wage rate. We use this imputed wage rate as a measure of the respondent's opportunity cost of time, and assuming sixteen waking hours per day, construct the respondent's "full income" (Becker 1965). See the attached appendix for the survey questions used, response categories, and the imputation of results. Hours dedicated to religious activities were multiplied by the wage rate, and then added to the dollars given to the respondent's religious congregation (tithing, R_X^{Baylor}) to determine the total dollar value of the respondent's involvement in his religious group. From this full income we are able to determine the fraction of a respondent's estimated full income that was dedicated to religious activity associated directly with his or her congregation.

(1) $$R_F^{Baylor} = \frac{(R_T \cdot w) + R_X}{w \cdot 16}$$

Figure 1 is a histogram of the log fraction of full income dedicated to religious activity (log R_F^{Baylor}).[5] Visual inspection suggests that the distribution of log R_F^{Baylor} is bimodal, with two distinct sub-distributions.

[FIGURE 1]

Establishing, statistically, that there are two distinct subdistributions within the population sampled from can be tricky, however. Kurtosis has been proposed as a direct statistical assessment of bimodality versus unimodality (Darlington 1970).[6] Kurtosis, however, is a less reliable measure of bimodality when the skew of the distribution does not equal zero. The SAS User's Guide (1989) includes a coefficient of bimodality, essentially kurtosis compensated for skew, that has become been used regularly in the biological sciences (Ellision 1987; Imbert et al. 1996).

(2)
$$\text{Bimodality} = \frac{skew^2 + 1}{raw\ kurtosis}$$

If *Bimodality* > 0.55, a distribution's bimodality is deemed significant. Log R_F^{Baylor} has a bimodality coefficient of 0.75. The bimodality coefficient, coupled with visual inspection, offers strong evidence of a bimodal structure. Table 1 includes the relevant statistics from the Baylor Survey in both level and log form. The raw kurtosis of the logged variables indicates possible

[5] The log of RF is calculated by $\log\left(\frac{R_T \cdot \text{w} + \text{R}_X + 1}{\text{w} \cdot 16}\right)$ to avoid truncation of zeroes.
[6] Kurtosis is here, defined as the fourth moment divided by the square of the second moment, Specifically, we are *not* using or reporting excess kurtosis here or anywhere in this paper.

bimodality. The skew compensated bimodality coefficients exceed the 0.55 threshold in the level and log form of every measure included. [7]

[TABLE 1]

The United States income distribution has been characterized using various distributions: lognormal, gamma, exponential, or some mix there of (McDonald and Ransom 1979; Majumder and Chakravarty 1990; Dragulescu and Yakovenko 2001). Recent analysis has demonstrated that the top 3 to 5% of the Italian income distribution is Pareto distributed, with the remaining still best understood as lognormal (Clementi and Gallegati 2005). Lognormal distributions are characterized by a PDF whose log is normally distributed. The US income distribution lognormal, unimodal, and does not have any significant cleavages or gaps. The log of R_F^{Baylor}, on the other hand, is visually and statistically bimodal, with two distinct subgroups that are at least somewhat symmetrical. In section 4 we introduce a club-theoretic model of religious identity, membership, and sacrifice that generates a similarly polarized distribution of religious commitment from a simulated population of agents with a lognormal distribution of income.

[7] DiMaggio et al. (1996) demonstrate that kurtosis can be used as a measure of the degree of bimodality (where the distribution is more bimodal as the kurtosis falls). Similarly, a distribution can be interpreted as "more bimodal" as the bimodality coefficient is increasing. While the bimodality of the logged measures exceeds the critical value for both time (R_T^{Baylor}) and monetary (R_X^{Baylor}) dedicated, the bimodality coefficient is significantly higher when both factors are included in the fraction of full income dedicated to religion (R_F^{Baylor}). The measure is also robust to the inclusion of different survey variables. For instance, the distribution remains visually and statistically bimodal if we exclude service attendance from the measure of religious group commitment.

3 Religious Divides Around the World: The 1998 ISSP

Religious divides are neither uniquely modern, nor uniquely American. Political struggles have often been fought from the opposing sides of religious chasms (Enyedi 2000; Reynal-Querol 2002; Clark and Kaiser 2003). There is, however, to our knowledge no theory to suggest that religious divides are a universal social property.[8] The 1998 International Social Survey Project: Religion II asked respondents from 30 different countries a battery of questions related to the time they committed to their religious affiliations. Survey questions, response categories, and value imputation are included in the appendix. Unfortunately, the ISSP does not include financial contributions to religious organizations, so we cannot calculate a religious fraction of full income. Instead, we analyze religious time commitments in terms of hours dedicated to religious activities (R_T^{ISSP}) and religious hours as a fraction of the total of religious and labor hours (R_{FT}^{ISSP}).

$$R_{FT}^{ISSP} = \frac{R_T}{R_T + S_T} \tag{3}$$

Sorting respondents by country reveals distributions of R_T and R_{FT} striking in the prevalence of multimodality. Visual inspection of Figure 2 finds the presence of two modes to be featured (often quite prominently) in the religious distributions of the surveyed nations. Calculation of distribution moments and bimodality coefficients confirms visual inspection. The distributions of R_T^{ISSP} had bimodality coefficients greater than the 0.55 test threshold in eighteen of the thirty countries reporting, with four countries narrowly missing the cutoff. In our labor hours adjusted measure of commitment in the international data, R_{FT}^{ISSP} , the results are even more

[8] This is not to dismiss theory and evidence suggesting that deliberating bodies (Sunstein 2002) or political candidates (Shapiro, Glaeser et al. 2005) naturally polarize, potentially around religious issues.

stark, with all twenty-nine[9] distributions of R_{FT}^{ISSP} testing positive for bimodality (see Appendix Table A1 for summary statistics by country). These findings suggest that religious polarization is a pervasive phenomenon and certainly not unique to the United States.

[FIGURE 2]

4 A Multi-Agent Model of Religious Groups

The economic theory of clubs has been used to study a variety of social phenomena (Buchanan 1965; Cornes and Sandler 1986). Within the economic study of religion, the club model has arguably been the most successful and frequently employed. Iannaccone's (1992) model of groups that require unproductive costs, termed "sacrifice and stigma," on the behalf of rational, utility-maximizing members is the foundation of this literature. The original model was influential for its ability to explain seemingly irrational behavior on behalf of voluntary members of prohibitive, highly stigmatized religious groups. It should be noted that there is nothing uniquely religious in the construction. It does not employ any supernatural considerations, and can be just as easily applied to secular groups notable for their sacrifice and stigma requirements, such as military units or college fraternities.

We construct our multi-agent computational model with mathematical underpinnings[10] explicitly based on Iannaccone's original model. All changes made to the model serve to adapt the original, relatively austere representative agent model to accommodate a population of heterogeneous agents operating with local spatial interactions across discrete units of time. Adapting the original model to multi-agent simulation framework allows us to test the

[9] There are only 29 countries with R_{RT} distributions because the New Zealand survey did not record respondent labor hours.

[10] For other examples of computational models related to political economy, see Kollman et al (2003).

implications of the club model of religion for an entire religious economy and observe the macro properties emergent within the population. Emergent population properties, in particular the distributional shape, are not analytically tractable (nor necessarily exist) in a representative agent model or a model with a relatively small number of agent "types." We are especially keen to know whether the club model, centered on sacrifice and stigma requirements, is sufficient to generate religious market polarization in a population of agents with unimodally distributed wages and homogeneous preferences.

The club model of religion begins with the premise that agents internally produce their own utility. This production relies on two inputs which are similarly produced by the individual in their secular (private) endeavors and their religious (group) endeavors. Both secular and religious production require commitments of time and money, each of which is limited in supply. Time endowments are homogenous across individuals, while money is a function of wages which are heterogeneous across the population. What makes the production of the religious input unique is the interdependence of religious production with other members of the group. This interdependence invites members to free ride – to be a member of the group and benefit from the religious production of other members while in turn neglecting her own religious production. Iannaccone's crucial insight was that the imposition of costly sacrifice and stigma requirements could mitigate the free rider problem, resulting in rational members whose choice to engage in more religious production increased not just their own utility, but the utility of all other members. Examples of group imposed sacrifice and stigma requirements include restrictions on dress, diet, sexual conduct, and social interactions that limit opportunities or stigmatize members by making their religious identity known to others. Such requirements are costly but are not directly productive.

Individuals are heterogeneous in their wages, but identical in their basic preferences. Similarly, religious groups are heterogeneous in their sacrifice and stigma requirements, but are identical in their capacity to produce a religious "club good." What can in turn emerge is a religious economy within which some groups succeed in attracting members and others fail. Within this economy, individuals will decide how best to invest their scarce resources – whether to produce their own utility by allocating their time and money to secular endeavors or to their chosen religious group. A spectrum of agent choices will also emerge, including the secular independent, the devout group member, and everything in between.

In the model constructed, each agent produces her own utility with a constant elasticity of substitution (CES) production function, with inputs of a secular, private good *S*, and a religious, club good *K*, preference parameters d_S and d_K, and a substitution parameter β. *S* and *K* are classic "Z-good" arguments in the utility function (Stigler and Becker 1977). *K* is produced with a Cobb-Douglas production function with constant returns to scale and inputs R_i, the individual's contribution, and Q_g, the "quality" of the other group members' contributions, with output elasticity parameters α and 1- α.

(4)
$$U_i = (d_S S_i^{\beta} + d_K K_i^{\beta})^{1/\beta}$$
$$K_i = (R_i^{\alpha} Q_g^{1-\alpha})$$

The group quality input, $Q_{g,i}$ is defined as a function of the average input $R_{g,j \neq i}$ across agent *i*'s neighbors ($j \neq i$) that are members of the group, *g*, being evaluated, a scalar $s > 0$, and the number of agent *i*'s neighbors that are members of group *g*, n_g.

(5)
$$Q_{g,i} = R_{g,j \neq i} \cdot s(1 - \frac{1}{1+n_g}))$$

$Q_{g,i}$ is strictly increasing in n_g, with diminishing marginal returns $(Q' > 0, Q'' < 0)$.[11] This formulation of $Q_{g,i}$ is an important mathematical change from the original model. The original model hinges on a Nash-Equilibrium assumption ($R_i = R_{j \neq i}$), therefore $R_{g,j \neq i} = R_i$, creating a prisoner's dilemma. In our model, agents have heterogeneous wage endowments and, in turn, differing utility maximizing responses to the behavior of others. As such, $R_i = R_{j \neq i}$ no longer necessarily holds true and the model ceases to have a closed-form equilibrium solution.[12] Because we are operating in a computer-aided framework, however, we are less dependent on finding closed-form solutions[13]. The utility function, for any given value of $Q_{g,i}$, contains only a single, global maximum, which allows the luxury of employing the relatively simple golden mean search optimization algorithm (Press 2002).

S and *R* are both Cobb-Douglas produced with inputs of goods, x_S and x_R (prices p_S and p_R); and time v_S and v_R; input elasticity parameters *a* and *b;* and production capacity parameters A_S and A_R. A_S is the dimension in which group sacrifice is implemented.

(6)
$$\begin{aligned} S_i &= A_S (x_{i,S}^a v_{i,S}^{1-a}) \\ R_i &= A_R (x_{i,R}^b v_{i,R}^{1-b}) \end{aligned}$$

[11] Additionally, Iannaccone's original model only deals with a single group, and which obviates the need for including the number of members in club quality.
[12] The computational model generates outcomes equivalent to the Nash Equilibrium outcome of Iannaccone's original model when constrained to a representative agent. The implied two-group outcome possibility can also be generated if two agent types are employed.
[13] The model is written in Java 1.5.1 using the MASON agent modeling library (Luke et al. 2005).

Agent's are exogenously endowed with a heterogeneous wage rate, w_i, and a uniform time endowment $V = v_{i,S} + v_{i,R}$. Using the envelope theorem, we can construct shadow prices π_R and π_S.[14] With agent specific shadow prices established, agent choice is an exercise in standard optimization constrained by the agents' exogenously endowed full income $(p_S x_{i,S} + p_R x_{i,R}) + (w_i v_{i,S} + w_i v_{i,R}) \leq I_i$ (Becker 1965), defined as the value of goods purchased and wages forgone to time invested, where w is the agent's wage rate and p_S and p_R are the prices for secular (x_S) and religious goods (x_R) .

Agents occupy spaces ("patches") on a two dimensional lattice (Figure 3). Agents are one to a patch. Agent neighbors consist of the square rings of patches surrounding them. An agent with a radius of one has a set of eight neighboring patches whose occupants make up their "neighborhood." A one unit larger radius adds the next consecutive ring of patches to the agents neighborhood. This is known within the cellular automata literature as the agent's "Moore" neighborhood. The lattice operates as a torus, wrapping around at the top and sides, allowing all agents to have the same number of neighbors. As such, there are no "edge effects." Within this spatial context agents engage in local (as opposed to global) optimization, choosing the group and personal investment in club production that maximizes utility in their own unique local context. While modern transportation and media technology have no doubt increased the reach of congregations, religious club goods remain largely local constructs. Given that each agent holds a unique set of coordinates and neighbors during any time step of the model, the spatial construct represents an important source of agent heterogeneity in the model.

14
$$\pi_S = p_S \ \partial x_S^* / \partial S \ + w_i \ \partial v_S^* / \partial S \ = 1/A_S \ \ p_S \ \ aw_i/(1-a)p_S \ ^{1-a} + w_i \ \ aw_i/(1-a)p_S \ ^{-a}$$
$$\pi_R = p_R \ \partial x_R^* / \partial S \ + w_i \ \partial v_R^* / \partial S \ = 1/A_R \ \ p_R \ \ bw_i/(1-b)p_R \ ^{1-b} + w_i \ \ bw_i/(1-b)p_R \ ^{-b}$$

[FIGURE 3]

In evaluating $Q_{g,i}$, agent *i* is evaluating agents currently occupying patches in her neighborhood who are members of group $g \in G$ where G= 0,1,2...m . The groups in set G are differentiated along required member sacrifice in private productivity parameter $A_{g,S}$, where:

$$A_{g,S}\begin{cases}1-0.9^{(m-g)}+\varepsilon & \text{if} \quad g>0 \\ 1 & \qquad\;\; g=0\end{cases} \tag{7}$$

The sacrifice that a group enforces comes at the expense of $A_{g,S}$, where the first group (*g* = 0) offers member private productivity parameter $A_{0,S}$ = 1 (no sacrifice) and the final group requires $A_{m,S} = \varepsilon$ (complete sacrifice, where ε is defined as an arbitrarily small value, 0.000001, to prevent division by zero). The resultant sacrifice is $1 - A_{g,S}$.[15]

4.1 Model Steps

A run of the model consists of initialization followed by a set number of time steps, summarized in the following time structure:

Step [t = 0] Initialization. The model creates and places agents randomly, one per patch. Agents are heterogeneous across wages, pulling random values from a lognormal wage distribution. Agents are randomly assigned an initial group from a set of *G* different groups. Upon their creation, agents optimize their values of *R* and *S* as a function of their wage and the sacrifice

[15] Different bases were tested for the sacrifice function. As the number of groups is increased, the model becomes more fine grained, but at the cost of speed and ease of data collection and analysis. The formula employed allows for finer grained analysis at the lower end of the sacrifice spectrum and sufficient variety at the higher end, while limiting the model to what proved to be a tractable number of groups.

required by their initial group in an iterated Cournot-Nash solution to a game that the agent plays against herself. This is the only time that agents will act without knowledge of their neighbors.

Step [t > 0]. Each model step consists of shuffling the order of agents and one at a time progressing through their ranks. When it is agent *i*'s turn, she will evaluate $Q_{g,i}$ for each prospective group, *g*, that is represented in her neighborhood.[16] The optimal *R* and *S* are determined for each potential group, with the agent joining the utility maximizing group. The choice of group for an agent is a function of her wage, each group's respective sacrifice demanded, the quantity and commitment (in terms of *R)* of the representatives of each group in her neighborhood, which is in turn a function of their wages and the decisions made by their neighbors, and so forth. The actual emergent collection of groups is a property of a, perhaps, surprisingly complex process for a model rooted in a standard CES structure.

5 Simulation Experiments and Results

Simulation testing of the model entails varying key parameters and testing their impact on the choices made by the interacting agents of the model. A simulation "run" of the model includes the initialization of the model and a subsequent number of time steps. We fix several parameters of the model exogenously for both tractability and functionality. Prices (p_R, p_S) and preference (d_R, d_S) are all set equal to one. There are sixty possible groups (m = 59), each of which is governed by a scale parameter $s = 1.25$. As demonstrated in Iannaccone's original paper, substitutability, β, must be greater than the output elasticity of *R*, α, for the sacrifice mechanism

[16] The set of groups considered always includes the zero-sacrifice group, regardless of whether a member resides in the agent's neighborhood.

to work.[17] Similarly, the output elasticities for goods and time within the internal production functions for *S* and *R* must be different, with *R* weighted towards the time input, relative to S ($a > b$). The necessary differentiation of weightings (i.e. $a \neq$ b) is intuitively understandable: if the two goods are indistinguishable, then the lower priced one will always be favored, and any sacrifice will cause the club to fail. If $S()$ and $R()$ employ inputs of goods and time differently, then the ratio of shadow prices depends on the agent's full income and her opportunity cost of time. It is assumed that club production places greater emphasis on its members' time than does private production (i.e. $a > b$). Club goods require individual participation – *absentia* or proxy representation diminishes the good for both the agent and other group members. For its tractability of generation and greater empirical accuracy at the lower end of the distribution, our model employs a lognormal distribution of full incomes. The key shape parameter, standard deviation of log full income, is taken from the United States Census Bureau (Jones and Weinberg 2000) and set equal to one.[18]

All runs of the model analyzed here include 2,500 agents operating on a 50 by 50 lattice, over no fewer than 100 time steps. The coefficient of substitutability, β = [0.5, 0.9], and mean wage, μ = [1, 6], are the key population parameters tested. We also vary the number of steps, T = [100, 500] in each run and the radius of agent neighborhoods, Radius = [1,9]. All parameters are varied uniformly, in discrete units. The full experiment includes 1,350 runs, each a different combination of parameter values.

In Figure 4 we can view the changing shape of the population distribution as we slowly increase substitutability. Each chart within Figure 4 presents a frequency histogram of the log

[17] Further, there is a lower bound to the substitutability parameter given the context of model. If β is too low, and club goods and private goods are sufficiently complementary, their resulting interdependence would make free riding a less beneficial strategy and sacrifice and stigma would be unnecessary.
[18] The actual empirical estimate is 0.98. We round to one for simplicity.

fraction of full income ($Log \frac{R_i}{FI_i}$) dedicated to religious club production across the 2,500 simulated agents within a single run of the model. The sequence of charts shows the effect of increased substitutability as the initially unimodal distribution, reflective of the underlying unimodal income distribution, is gradually pulled apart and polarized into a bimodal distribution.

[Figure 4]

Ordinary Least Squares (OLS) regression modeling of the moments and bimodality coefficients of the distribution of $Log \frac{R_i}{FI_i}$ across runs (Table 2) confirms what can be observed in Figures 4. Bimodality of $Log \frac{R_i}{FI_i}$ is increasing with substitutability, observable in the coefficients on substitutability for regression models of the distribution's kurtosis and bimodality coefficient. The skewness of the distribution, however, is strictly moved by the mean wage of the population, with the modal individual engaging in less religious group production as the population enjoys higher wages. Lowering the mean population wage pulls the population towards more time intensive club production (higher $Log \frac{R_i}{FI_i}$), while higher wages pull the mean left, towards more relatively good intensive private production (lower $Log \frac{R_i}{FI_i}$). Greater substitutability, on the other hand, offers agents better prospects of specializing in either club or private production, and the great prospect of specialization polarizes the distribution. Weaker substitutability (and in turn, greater complementarity) of private and club utility inputs, on the other hand, squeezes the distribution together, as agents have greater incentive to balance private and club productive activities.

[Table 2]

The coefficients on the mechanical parameters tested, number of time steps and agent neighborhood radius are also reported in Table 2. Visual inspection of model visualizations (see Figure 3) reveals that the greatest population churn occurs in the first hundred steps, after which the model settles into a steady state.[19] Varying the experiment between 100 and 500 steps found no statistical change in the model results; the coefficient on time steps is small and statistically insignificant, approximating zero. Neighborhood radius has a sizeable and statistically significant impact on all four measures of the distribution. The mean, kurtosis, and bimodality of $Log\frac{R_i}{FI_i}$ across the population is increasing with neighborhood radius, which skewness is decreasing. Group quality Q_j, in the model includes early returns to scale (see Equation 5), and as such, larger radii increase the potential value of Q_j, increasing the average return to group commitment, and in turn the mean of $Log\frac{R_i}{FI_i}$. The increase in bimodality and kurtosis with radius also has an intuitive explanation. As radius increases, agents have a greater selection of local groups to choose from, making them more likely to find a club whose sacrifice rate approaches their ideal club, which increases the segmentation of the market for groups. In smaller radius runs, agents must compromise more, and join clubs that engender a level of commitment that differs further from their optimal situation, pulling agents towards the median. This could be construed as a lowest common denominator effect,

[19] This is not surprising given the absence of agent mobility in the model. The results would likely be more sensitive to the number of time steps if agents were changing locations within the model.

6 Discussion

The bimodality of the data imputed from the Baylor University Religious Survey of the U.S., the international data from the ISSP, and the results of our club-theoretic model simulations reinforce the idea that religious polarization within populations is real, ubiquitous, and a property emergent of religious club formation. This pervasive bimodality of religious commitment, in light of the observed connection between religious values and politics, has interesting political ramifications under a winner take all, majority rule democracy. Econometricians (Bassett Jr. and Persky 1999) and historians of economic thought (Levy and Peart 2002) have identified voting as a form of statistical estimation. Following from this logic, majority rule has statistical properties equivalent to the median. Bimodal distributions have the peculiar property that the mean is a more robust sample estimator than the median; the opposite holds true for symmetric, unimodal distributions. A median estimate of a limited sample from a bimodal distribution is non-robust (Mosteller and Tukey 1977; Levy 1989); different samples can result in significantly different estimates. In fact, much of what makes the median a preferred estimator of samples in events such as elections is turned on its head when the population distribution is bimodal. These issues are exasperated as the sample size shrinks.

If a population voted along a single issue dimension, and the population distribution along that issue was bimodal, we could expect that majority voting as a sample estimator would be non-robust. As such, the margin of error associated with the sampling mechanism could be sufficient to change the reported majority winner, even when the candidates occupy significantly different places on the policy continuum on which they were evaluated. We may have witnessed just such an outcome in the 2000 U.S. Presidential election, where different counts from the Florida electoral vote yielded different winners, and votes associated with the notorious

"Butterfly" errors[20] were sufficient to swing the election one way or the other (Wand, Shotts et al. 2002). The convergence of economic preferences observed by Ansolabeohere et al. (2006) and the domination of religiosity over income in voter decision making observed by Glaeser and Ward (2006), coupled with a bimodal religious commitment distribution, provide a setting within which majority rule is a considerably less robust estimator of voter preferences. Non-robustness of majority rule derivative of the salience of religious commitment and identity is a means by which a relatively small voter or vote counting error could swing an election disproportionately far from the population median. Given the preponderance of surveyed countries with bimodal distributions of religious commitments, we can anticipate a lower robustness of majority rule as an estimator of voter preferences in countries where religious values supersede economic values in voter decision-making.

The US culture divide, heretofore discussed almost exclusively in terms of religious commitment, has been frequently portrayed in the media in strongly regional terms, popularized as the red state - blue state phenomenon. Electoral maps from the 2000 and 2004 presidential elections are noticeably similar, with the south distinctly red and the west distinctly blue. The United States has been characterized by a distinct religious regionalism for more than a 100 years now, a regionalism that, until recently had presented a puzzle without solution (Stark et al. 1985; Smith et al. 1998). Iannaccone and Makowsky (2007) offer a model that explains the persistence of religious regionalism under conditions of exogenous agent mobility. Given the increasing impact of religion in voter preferences, it should not come as a surprise if regional voting trends similarly persist.

[20] The famed "Butterfly" errors were resultant of ballots on which the candidate and their associated hole-punch were not in horizontal alignment, confusing many voters and resulting in a non-trivial number individuals voting for the someone other than their intended candidate. The most common story was told of elderly voters who intended to vote for Al Gore instead voting for Pat Buchanan.

Although our multi-agent model characterizes people in a relatively simple way, the resulting polarization of the population is compelling. Making sense of the observed parameter correlations in the simulation experiments requires little more than basic economic intuition. The agent population polarizes with regard to religious group commitment as club goods and secular private goods become better substitutes. When substitutability is high, the high wage agents will shift disproportionately towards goods-intensive private production, while low wage agents with shift toward time-intensive club production. On a related level, the correlation of population skew to wages makes sense as well – lower population wages make for more agents pursuing time intensive club production, and vice versa.

In the model constructed, there is a demonstrated minimum level of substitutability for the population to polarize in terms of religious commitment and group membership. For this story of religious polarization to hold for the American population, religious club goods must be a sufficiently strong substitute for privately produced secular goods. In an empirical study of the impact on welfare laws on church contributions, Hungerman (2003) found that a one dollar decrease in county-wide per capita welfare spending lead to an increase of 0.40 dollars in a PCUSA congregations per-member spending on local community projects. In a related study of church spending and market opportunities, Gruber and Hungerman (2006) found that increased secular opportunities through the repealing of blue laws led to 6.3 percent fall in per member church spending. Their findings are indicative of a level of substitutability that is at least compatible with the club-theoretic story of naturally emergent polarization of religious commitment and religious groups in the United States.

7 Conclusions

Religious bimodality matters not just for matters of social cohesion and cultural "wars" but also for the stability of majority rule voting in democratic elections. Majority rule democracies will be less stable whenever voter preferences are bimodality on a salient issue. Instability will be further exacerbated when voter preferences on other salient issues are unimodal and inspire convergence in candidate platforms.

Empirical evidence from the Baylor Religious Survey demonstrates a divide with respect to religious commitment and identity. This supports the cultural divide literature that emphasizes the importance of religion and "moral values." Moreover, international data suggests that religious divides are fairly common. Simulation data from a multi agent implementation of the club model of religion generate polarization in the distribution of religious commitment across a wide range of parameter values. The data and model presented here suggest that religious polarization is the norm, and is a naturally emergent population characteristic of collectively-oriented religion.

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Table 1. Baylor Survey 2005 Religious Commitment Distribution Statistics

VARIABLE	MEAN	STD. DEV.	SKEWNESS	KURTOSIS	BIMODALITY
Religious volunteered hours (R_T)	116.93	182.53	2.64	12.87	0.62
Religious tithing (R_X)	1385.24	2609.93	3.41	16.40	0.77
Fraction of Full Income (R_F)	3.56 %	5.37 %	2.49	11.46	0.63
Log religious volunteered hours (log R_T)	3.07	2.26	-0.10	1.51	0.67
Log tithing (log R_X)	4.85	3.22	-0.61	1.85	0.71
†Log fraction of full Income (log R_F)	-5.75	3.57	-0.87	2.38	0.75

N = 1,721 † The log of the "fraction of full income" is calculated by $\log\left(\frac{\text{hours volunteering} \cdot \text{wage}) + \text{dollars tithed} + 1}{\text{Full Income}}\right)$ to avoid truncation of zeroes.

Table 2 Simulated Model Data, Log Fraction of Full Income Distribution (statistical moments)

	(1) Mean	(2) Skew	(3) Kurtosis	(4) Bimodality
Substitutability(β)	-9.549***	-0.081	-7.903***	1.500***
	(0.148)	(0.161)	(0.590)	(0.025)
Mean Wage	-0.553***	0.312***	0.878***	-0.037***
	(0.011)	(0.012)	(0.045)	(0.002)
Radius	0.024***	0.018**	-0.112***	0.019***
	(0.007)	(0.007)	(0.027)	(0.001)
Steps	-0.000	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.001)	(0.000)
Constant	4.536***	-0.102	7.508***	-0.283***
	(0.124)	(0.135)	(0.495)	(0.021)
R-squared	0.831	0.330	0.303	0.765

N = 1,350 (separate runs). Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Substitutability ranges uniformly between 0.5 and 0.9, Mean Wage between 1 and 6. Neighborhood radius between 1 and 9. Models steps between 100 and 500. Each run of the model simulates 2,500 agents.

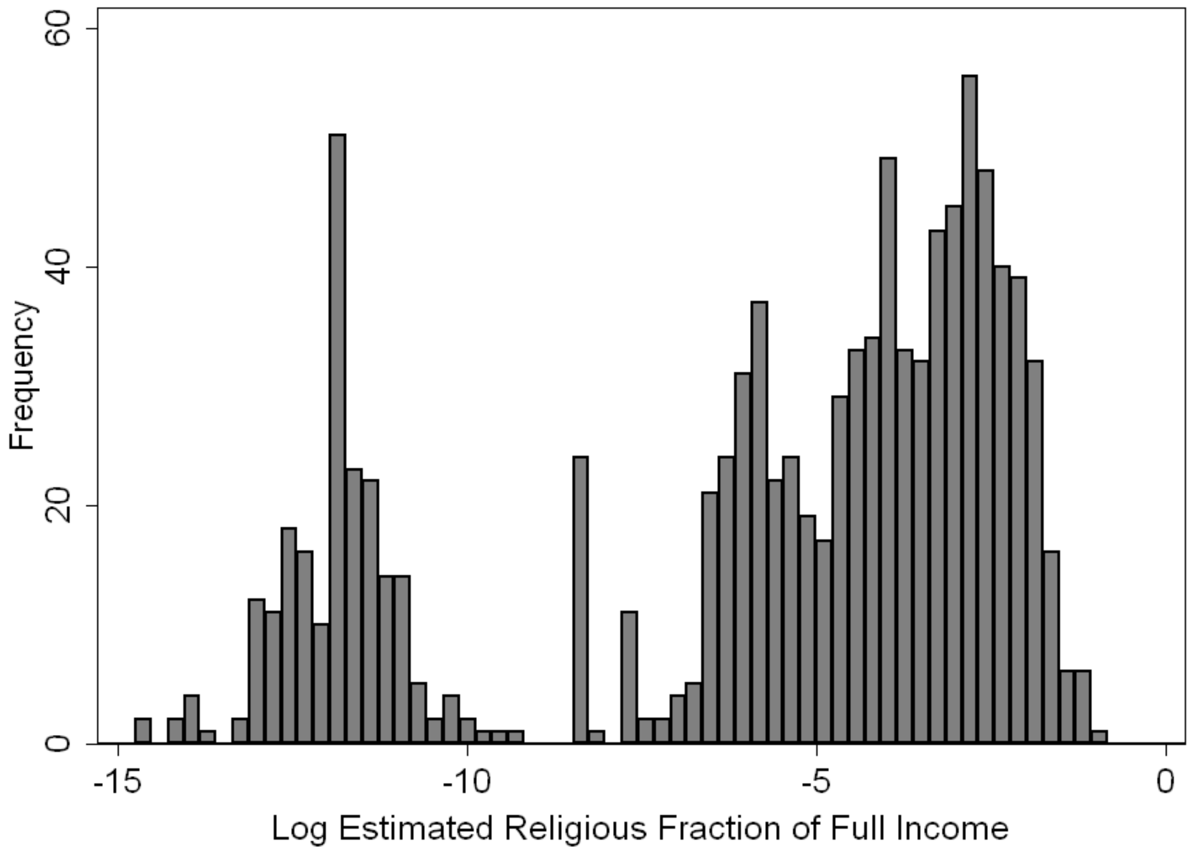

Figure 1. Baylor survey - Histogram of the Logged fraction of full income dedicated to activities relevant to the religious congregation. N = 1,721

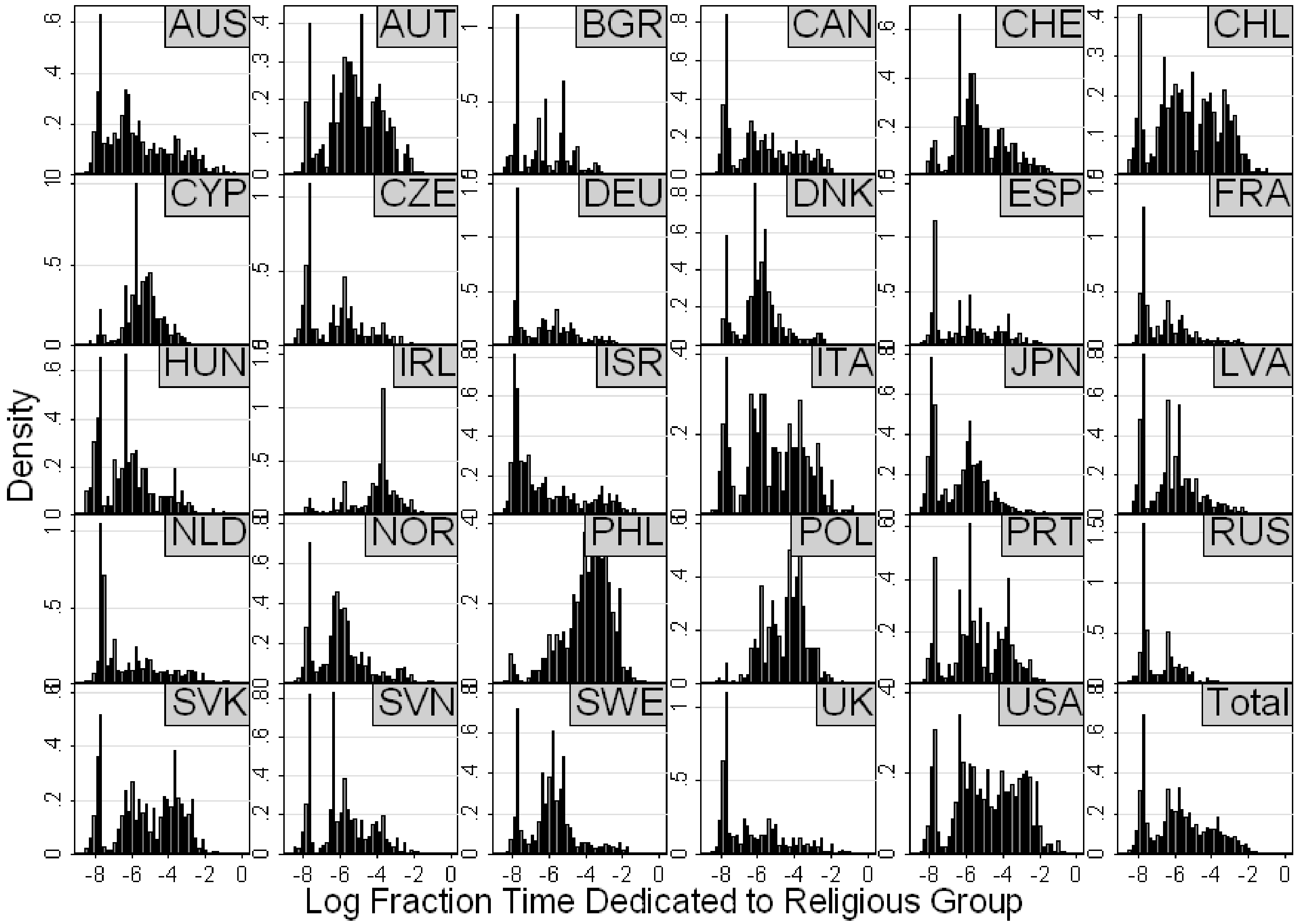

Figure 2. Density Histogram of Log Religious Fraction of Time by Country, y-axis rescaled. Key: Australia (DNK) France (FRA) Germany (DEU) Hungary (HUN) Ireland (IRL) Israel (ISR) Italy (ITA) Japan (JPN) Latvia (LVA) Netherlands (NLD) New Zealand (NZL, excluded from figure) Norway (NOR) Philippines (PHL) Poland (POL) Portugal (PRT) Russia (RUS) Slovak Republic (SVK) Slovenia (SVN) Spain (ESP) Sweden (SWE) Switzerland (CHE) United Kingdom (UK) United States (USA)

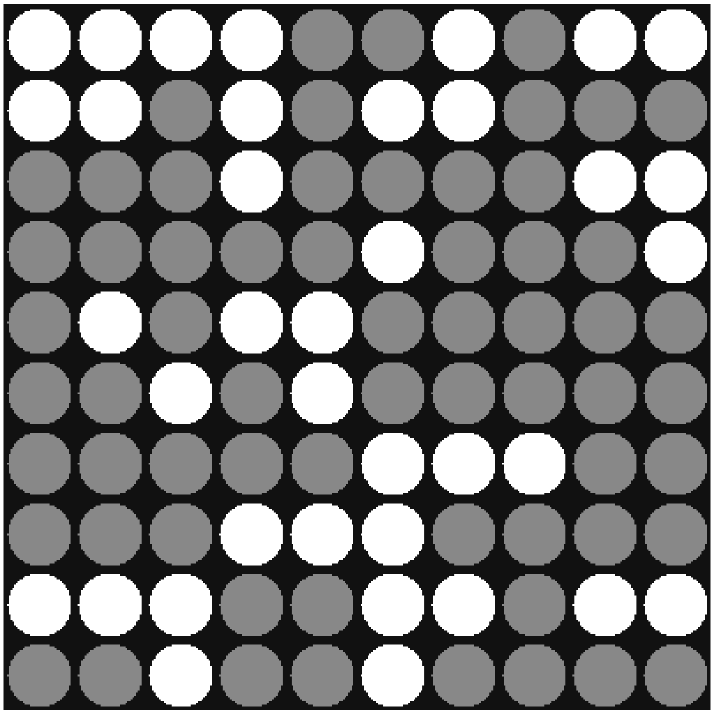

Figure 3 10 by 10 lattice (50 by 50 lattice used in actual simulations). Different colors correspond to group membership.

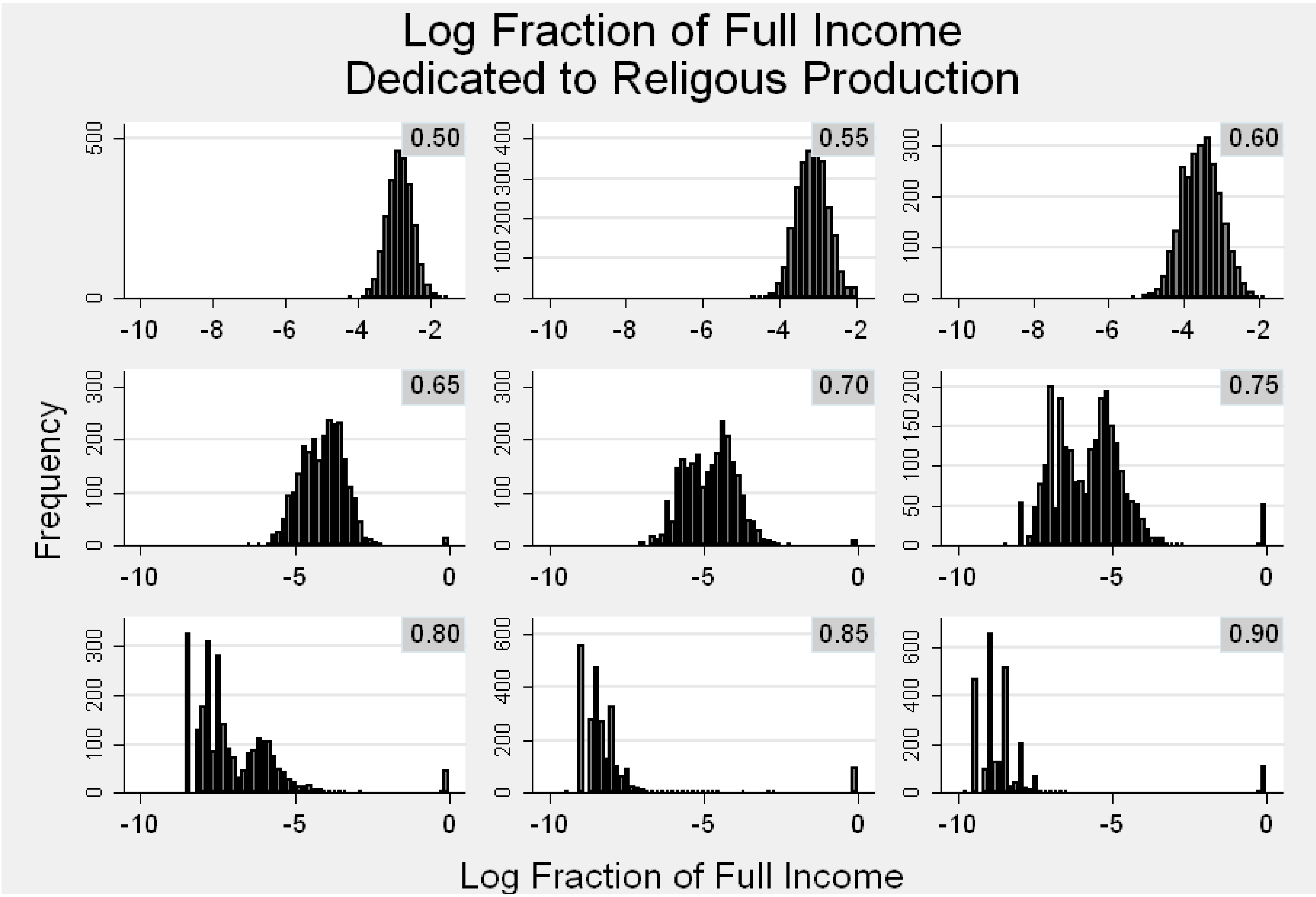

Fig 4 Histogram of Log Fraction of Full Income, Graphed by Beta (N = 2,500). Model Simulation results after 200 steps, Mean Wage = 6, Neighborhood Radius = 1. Y axes are rescaled in each graph.

Appendix

Table A1. Bimodality of Religious Commitment Distribution, ISSP 1998
(R_T = Time dedicated to religious group, R_{FT} = Fraction of time dedicated to religious group)

Country	Bimodal (Log R_{FT})	Bimodal (Log R_T)	Mean (Log R_T)	Std Dev (Log R_T)	Skewness (Log R_T)	Kurtosis (Log R_T)
Australia	0.80	0.65	1.89	1.84	0.60	2.08
Austria	0.72	0.48	2.50	1.53	-0.13	2.12
Bulgaria	0.63	0.54	1.43	1.37	0.58	2.45
Canada	0.60	0.63	1.97	1.85	0.44	1.89
Chile	0.68	0.55	2.72	1.77	-0.13	1.85
Cyprus	0.59	0.34	2.17	1.10	-0.21	3.06
Czech Republic	0.67	0.61	1.45	1.54	0.68	2.41
Denmark	0.80	0.39	1.77	1.26	0.58	3.43
France	0.74	0.68	1.44	1.64	0.87	2.61
Germany	0.70	0.63	1.49	1.59	0.69	2.36
Hungary	0.78	0.54	1.75	1.48	0.47	2.26
Ireland	0.57	0.63	3.48	1.34	-1.18	3.79
Israel	0.65	0.79	1.32	1.83	1.05	2.65
Italy	0.75	0.55	2.76	1.74	-0.20	1.89
Japan	0.78	0.49	1.44	1.35	0.42	2.40
Latvia	0.69	0.50	1.60	1.42	0.54	2.59
Netherlands	0.75	0.75	1.47	1.83	0.78	2.13
New Zealand	N/A*	0.59	2.07	1.80	0.47	2.06
Norway	0.78	0.53	1.67	1.47	0.82	3.18
Philippines	0.58	0.55	3.76	1.30	-1.05	3.84
Poland	0.55	0.50	3.33	1.21	-0.90	3.59
Portugal	0.61	0.47	2.57	1.52	-0.15	2.16
Russia	0.82	0.61	0.90	1.18	1.23	4.11
Slovak Republic	0.55	0.59	2.66	1.79	-0.19	1.76
Slovenia	0.71	0.54	1.92	1.56	0.30	2.01
Spain	0.63	0.59	2.07	1.71	0.15	1.74
Sweden	0.84	0.43	1.76	1.40	0.66	3.35
Switzerland	0.67	0.42	2.33	1.33	0.40	2.77
United Kingdom	0.78	0.66	2.15	1.93	0.22	1.58
United States	0.65	0.57	2.86	1.84	-0.14	1.78

* Labor hours unavailable for New Zealand Respondents, making the fractional assessment impossible

Imputation of Religious Commitment Variables from the Baylor 2005 Survey

1) Income (per year), using categorical responses to Question 60

Q60) By your best estimate, what was your total household income last year, before taxes?

Income = 5000 if Question 60 = 1
Income = 15000 if Question 60 = 2
Income = 27500 if Question 60 = 3
Income = 42500 if Question 60 = 4
Income = 75000 if Question 60 = 5
Income = 125000 if Question 60 = 6
Income = 200000 if Question 60 = 7

2) Wage (per hour)

$$\text{Wage} = \frac{\text{Income}}{\text{Hours worked last week} \cdot 52}$$

Where "hours worked last week" were numerical responses to Question 62.

3) Tithe (per year) using categorical responses to Question 11

Q11) During the last year, approximately how much money did you and other family members in your household contribute to your current place of worship?

Tithe = 0 if Question 11=.
Tithe = 250 if Question 11=1
Tithe = 750 if Question 11=2
Tithe = 1500 if Question 11=3
Tithe = 2500 if Question 11=4
Tithe = 3500 if Question 11=5
Tithe = 4500 if Question 11=6
Tithe = 5500 if Question 11=7
Tithe = 6500 if Question 11=8
Tithe = 7500 if Question 11=9
Tithe = 8500 if Question 11=10
Tithe = 9500 if Question 11=11
Tithe = 15000 if Question 11=12

4) Service Time (translated to hours per year) using categorical responses to Question 5

Q5) How often do you attend religious services?

Service time = 0 if Question 5 = 1
Service time = 1 if Question 5 = 2
Service time = 2 if Question 5 = 3
Service time = 6 if Question 5 = 4
Service time = 12 if Question 5 = 5

Service time = 30 if Question 5 = 6
Service time = 44 if Question 5 = 7
Service time = 52 if Question 5 = 8
Service time = 104 if Question 5 = 9

5) Religious Activities Time (Monthly)
Q14a-j) How often did you participate in the following religious activities last month?

Question 14 a through j, religious activities (per month), where "religious time" is the sum of responses to 14 a through j.
$x \in \{a, j\}$

Activity Time a = 0 if Question 14x = 1
Activity Time a = 3 if Question 14x = 2
Activity Time a = 7 if Question 14x = 3
Activity Time a = 15 if Question 14x = 4

6) Volunteering through the Church (translated to per Year)
Q48a) On Average, how many hours per Month do you volunteer through the church?

Volunteering1 = 0 if Question 48a =1
Volunteering1 = 18 if Question 48a =2
Volunteering 1= 42 if Question 48a =3
Volunteering 1= 90 if Question 48a =4
Volunteering 1= 180 if Question 48a =5

7) Volunteering for the Church (translated to per Year)
Q48c) On Average, how many hours per Month do you volunteer for the church?

Volunteering2 = 0 if Question 48c =1
Volunteering 2= 18 if Question 48c =2
Volunteering 2= 42 if Question 48c =3
Volunteering 2= 90 if Question 48c =4
Volunteering2 = 180 if Question 48c =5

8) Total Volunteering = Volunteering1 + Volunteering2
These imputed factors allow for the following calculation:

9) $$\text{Religious time} = \text{Total Volunteering} + (\text{Activity time} \cdot 12) + \text{Service time}$$

10) $$\text{Religious fraction} = \frac{(\text{Religious time} \cdot \text{Wage}) + \text{Tithe}}{\text{Full Income}}$$

Imputation of Religious Commitment Variables from the ISSP 1998 Survey

Quesiton 218) How often do you attend religious services?
Service time = 52 if Question 218 ==1 (once a week or more)
Service time = 30 if Question 218 ==2 (2-3 times a month)
Service time = 12 if Question 218 ==3 (Once a month)
Service time = 6 if Question 218 ==4 (Several times a year)
Service time = 3 if Question 218 ==5 (Less frequently than once a year)
Service time = 0 if Question 218 ==6 (Never)
Service time =. if Question 218 ==8 (Don't know)
Service time =. if Question 218 ==9 (No Answer)

Question 34) Volunteer work during the last 12 months in: Religious and church-related activities (helping churches and religious groups)

Volunteering time = 0 if Question 34 == 1 (No)
Volunteering time = 8 if Question 34 == 2 (Yes, once or twice)
Volunteering time = 20 if Question 34 == 3 (Yes, 3 – 5 times)
Volunteering time = 40 if Question 34 == 4 (Yes, 6 or more times)
Volunteering time = missing value if Question 34 == 9 (No answer)

Question 59) How often do you take part in the activities of a church or a place of worship, other than attending services?

Activities time = 0 if Question 59 == 1 (Never)
Activities time = 2 if Question 59 == 2 (Less than once a year)
Activities time = 4 if Question 59 == 3 (About once or twice a year)
Activities time = 12 if Question 59 == 4 (2-3 times a year)
Activities time = 24 if Question 59 == 5 (Nearly every week)
Activities time = 72 if Question 59 == 6 (2-3 times a month)
Activities time = 80 if Question 59 == 7 Nearly every week
Activities time = 104 if Question 59 == 8 (Every week)
Activities time = 220 if Question 59 == 9 (Several times a week)
Activities time = missing value if Question 59 == 98 or 99
Activities time = missing value if Question 59 == 99
Question 23) How many hours did you work last week?
Labor Time = Question 213 * 52

These imputed factors allow for the following calculation:

9) $$\text{Religious time}_i^{ISSP} = \text{Volunteering}_i^{ISSP} + \text{Activity time}_{\text{i}}^{\text{ISSP}} + \text{Service time}_{\text{i}}^{\text{ISSP}}$$

10) $$\text{Religious fraction}_i^{ISSP} = \frac{\text{Religious time}_i^{ISSP}}{(\text{Religious time}_i^{ISSP} + \text{LaborTime}_i^{ISSP})}$$