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 Religion reveals a bimodal distribution of religious commitment in the US. International survey data reveals bimodal distributions in twenty-eight of thirty surveyed countries. The club theory of religion, when applied in a multi-agent model, generates bimodal distributions of religious commitment whose emergence correlates to substitutability of club goods for standard goods and the mean population wage rate. Ramifications of religious bimodality include potential instability of majority rule electoral outcomes. Median estimators, such as majority rule democracy, are non-robust with bimodal distributions. When religion is politically salient and polarized, small errors can disproportionately shift the election result from the preferences of the median voter.

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

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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 cultural divides 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 (Abramowitz and Saunders 2005; Hunter 1991), others against it (Fiorina et al. 2005; Ansolabehere et al. 2006; DiMaggio et al. 1996; Wolfe 1998). 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. 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 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 unclear. 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 et al. 2006). Resolution can be found in the distributional shapes of these two factors within the American population, which, in the context of the median voter theorem, lead to very different responses from vote-maximizing politicians. The unimodal distribution of economic preferences should lead to strong convergence in the platforms of competing politicians (Black 1948). Ansolabehere et al find religious culture and moral values, however, to be bimodal, from which greater platform divergence should follow. 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, givens 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 wider significance. Separate religious, and not political, subpopulations are relevant to the current political landscape, particularly in the context of a unimodal distribution of economic preference. 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 importance of a religious divide goes beyond what is shaping voter preferences, however. In statistical analysis, bimodal distributions have the peculiar property that the median is a less-robust estimator of central tendency than the mean. As such, the median of voter preferences will be considerably more influenced by small sample differences when the distribution is bimodal. Under this scenario, we can expect that small disturbances are more likely to generate large changes in election outcomes. Accord 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. Given the statistical properties of bimodal distributions and the preponderance of surveyed countries with bimodal distributions of religious commitment, we can anticipate that majority rule will be a less stable estimator of voter preferences in countries where religious values supersede economic values in voter decision-making.

2 The US Religious Divide

The hypothetical 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) offer evidence supporting the Fiorina et al claim, with empirical evidence that voting preferences are a greater function of economic preferences, that there is remarkably complete convergence 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. Glaeser and Ward highlight strong state to state heterogeneity of surveyed responses to statements, several of which carry a religious connotation.[1] 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.

2.1 The Baylor Religion Survey

In 2005 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). Hours dedicated to religious activities were multiplied by the wage rate, and then added to the dollars given to the

[1] 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].

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.[2]

(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}).[3] Inset in the figure is the histogram of linear R_F^{Baylor} . The inset figure is heavily skewed, while the log figure is considerably more symmetrical. Visual inspection suggests that the distribution of log R_F^{Baylor} is likely 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 (Darlingotn 1970).[4] Kurtosis, however, is a less reliable measure of bimodality when the skew of the distribution does not equal zero. The SAS User's Guide (*SAS/STAT User's Guide* 1989) includes a coefficient of bimodality,

[2] Baylor Survey questions used for approximate religious commitment: Questions 60 (income), 62 (hours worked last week), 11 (dollar amount donated to your church), 5 (religious service attendance frequency), 14a – 14j (hours spent in different religious activities), and 48c (hours volunteering for your church).

[3] The log of RF is calculated by $\log\left(\frac{R_T \cdot \mathrm{w} + \mathrm{R}_X + 1}{\mathrm{w} \cdot 16}\right)$ to avoid truncation of zeroes.

[4] 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.

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 bimodality. The skew compensated bimodality coefficients exceed the 0.55 threshold in the level and log form of every measure included. [5]

[TABLE 1]

The United States income distribution has been characterized using various distributions: lognormal, gamma, exponential, or some mix there of (Dragulescu and Yakovenko 2001; Majumder and Chakravarty 1990; McDonald and Ransom 1979). Recent analysis has demonstrated that the Italian income distribution is top 3 to 5% is Pareto distributed, with the remaining still best understood lognormal (Clementi and Gallegati 2005). Lognormal distributions are characterized by a PDF whose log is normally distributed, which the US income distribution demonstrates without any significant cleavages or gaps. The log of R_F^{Baylor} is visually and statistically bimodal, with two subgroups that are at least somewhat symmetrical. This

[5] 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}).

suggests the existence of two sub-distributions that share a skewed shape similar to the income distribution and, in turn, a connection between religious commitment and income. In section 4 we will 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.

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 (Clark and Kaiser 2003; Enyedi 2000; Reynal-Querol 2002). There is, however, to our knowledge no theory to suggest that religious divides are a universal social property.[6] 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. 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}).

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

Sorting respondents by country reveals distributions of R_T and R_{FT} striking in the prevalence of multimodality. Visual inspection of Figure 2 finds bimodality prominently featured

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

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 twenty-eight of the thirty countries reporting, with two countries narrowly missing the cutoff. Twenty-five of the twenty-nine[7] ISSP distributions of R_{FT}^{ISSP} tested positive for bimodality, with two narrowly missing the cutoff (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 (Cornes and Sandler 1986; Buchanan 1965). 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

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

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 [8]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 in this manner allows us to test the implications of the club model of religion for an entire religious economy and observe the macro properties emergent within the population. 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

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

more religious production increased not just their own utility, but the utility of all other members.

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 the 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.

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

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

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

$Q_{i,g}$ is strictly increasing in n_g, with diminishing marginal returns $(Q' > 0, Q'' < 0)$. This formulation of $Q_{i,g}$ is an important mathematical change from the original model. The original model hinges on a Nash-Equilibrium assumption ($R_i = R_{j\neq i}$), creating a prisoner's dilemma. In our model, agents are able to observe local agent behavior different from their own, and in turn inform their own decision-making. As such, $R_i = R_{j\neq i}$ no longer necessarily holds true and the model ceases to have a closed-form equilibrium solution[9]. Because we are operating in a computer-aided framework, however, we are less dependent on finding closed-form solutions[10]. The utility function, for any given value of $Q_{i,g}$, 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) $$S_i = A_S(x_{i,S}^{a} v_{i,S}^{1-a})$$
$$R_i = A_R(x_{i,R}^{b} v_{i,R}^{1-b})$$

[9] 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.
[10] 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.[11] 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, and have a set of eight neighboring patches whose occupants make up their "neighborhood." 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. 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.

[FIGURE 3]

In evaluating $Q_{i,g}$, 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_S^g, where:

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

$$A_S^g \begin{cases} 1-0.9^{(m-g)}+\varepsilon & \text{if} \quad g>0 \\ 1 & \phantom{\text{if}} \quad g=0 \end{cases} \tag{7}$$

The sacrifice that a group enforces comes at the expense of A_S^g, where the first group (g = 0) offers member private productivity parameter $A_S^0 = 1$ (no sacrifice) and the final group requires $A_S^m = \varepsilon$ (complete sacrifice, where ε is defined as an arbitrarily small value to prevent division by zero). The resultant sacrifice is $1 - A_S^g$.[12]

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 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 $Q_{i,g}$ for each prospective group, *g*, that is represented in her neighborhood[13]. The optimal *R* and *S* are

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[12] 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.

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

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 to work. 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 differentiation of goods 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.

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.[14]

All experiments conducted here include 10,000 agents operating on a 100 by 100 lattice, with 100 time steps constituting a run. The coefficient of substitutability, β, and mean wage, μ, are the key parameters tested. We ran two related experiments. The first experiment varies the β in increments of 0.02 between 0.4 and 0.9, inclusive, holding the mean wage of the population constant. The β parameter is isolated in an effort to understand the progressive effects of substitutability on the shape of the population distribution of religious sacrifice and religious commitment. In the second experiment, but both β and μ are tested as uniform random variables tested within ranges of 0.6 to 0.9, and 1 to 5, respectively.

In Figure 4a we can view the changing shape of the population distribution as we slowly increase substitutability. Each chart within Figure 4a presents a frequency histogram of the log fraction of full income dedicated to religious club production across the 10,000 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 4a and Figure 4b]

[14] The actual empirical estimate is 0.98. We round to one for simplicity.

The second, related experiment includes 1,200 runs of the model with randomized values of β and μ is represented in a scatter plot of the bimodality coefficients from each run. Runs are organized by β parameters on the x axis, and color and shape coded for differing bands of μ parameterizations (Figure 4b). Bimodality is increasing with substitutability and decreasing with higher mean wages. The lower income populations are more immediately inclined towards a religious cleavage, with bimodality coefficients above the 0.55 threshold even at the lowest tested values of substitutability. Further, the slope coefficient on substitutability is increasing in higher wage bands. Ordinary Least Squares (OLS) regression modeling of the distributional moments and bimodality coefficients (Table 3) confirms what can be observed in Figures 4a and 4b. Bimodality 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 population, with the modal individual engaging in more religious group production as the population enjoys higher wages. These results reflect what is logically inferable from the model. Low wages pull the mean right, towards more time intensive club production, while higher wages pull the mean left, towards more relatively good intensive private production. Greater substitutability, on the other hand, offers agents better prospects of specializing in either club or private production, and the great prospect of specialization pulls the distribution apart. 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]

6 Discussion

The bimodality of the data imputed from the Baylor Religious Survey of the U.S., the international data from the ISSP, and the results of our club-theoretic model simulations reinforce each other and 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. Voting is a form of statistical estimation (Levy and Peart 2002). 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 non-normal, symmetric unimodal distributions. A median estimate of a limited sample from a bimodal distribution is non-robust (Levy 1989; Mosteller and Tukey 1977). Different samples can result in significantly different estimates.

Bootstrap analysis[15] allows us to test and compare the robustness of the median and the mean as estimators of U.S. religious commitment, in this case the log fraction of imputed full income dedicated to the respondent's religious group (log R_F). We can look at the distribution of sample estimates and compare how the mean and median fare with different sample sizes. Table 4 reports the bias, standard error, and mean squared error (bias^2 + variance) of the distribution of mean and median estimates of the 1000 bootstrapped samples created, across 4 different sample

[15] Bootstrapping is essentially replicating the analysis on data created by sampling from the full data set, with replacement. It is frequently used as a means of testing the sensitivity of various estimates to differing sets of observations sampled from the same population or data generating process. For an introduction to bootstrap methods, see Efron and Tibshiriani (1993) .

sizes (25%, 50%, 75%, and 100% of the original sample size, N = 1,721) . All three measures find the median to be less robust than the mean, an outcome likely attributable to the bimodal nature of the distribution, and itself further evidence that the distribution is in fact bimodal. Perhaps most striking, however, is the discrepancy between the bias of mean and median estimates. The most recent U.S. Presidential elections lured 54% of eligible voters to polls. One thousand bootstrap replications using sample equal to 50% of the full data set resulted in median estimates with a standard error equal to 2.9% of the population mean, and bias three times larger than the bias associated with the mean. This is not to imply that a similar sized bias would be realized across a much larger national or state population, but rather to show the sensitivity of the median to sampling properties when the distribution is bimodal. 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.

[TABLE 3]

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[16] were sufficient to swing the election one way or the other (Wand 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.

[16] 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 the 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 move 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 multimodality 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 multimodal 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. Thus it would appear 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, 1200 runs, 100 time steps per run, 10,000 agents

	(1) Mean	(2) Skew	(3) Kurtosis	(4) Bimodality
Substitutability(β)	-13.026*	0.022	-11.676*	2.137*
	(0.175)	(0.182)	(0.497)	(0.027)
Mean Wage	-0.872*	0.540*	2.088*	-0.095*
	(0.013)	(0.014)	(0.037)	(0.002)
Constant	7.925*	-0.490*	7.298*	-0.604*
	(0.138)	(0.144)	(0.391)	(0.021)
Observations	1200	1200	1200	1200
R-squared	0.89	0.57	0.76	0.88

Standard errors in parentheses. * significant at the 0.01 percent level. Substitutability ranges uniformly between 0.6 and 0.9, Mean Wage between 1 and 5.

Table 3. Bootstrap Standard Errors of Estimators of Log R_F under Different Sampling Conditions, across 1000 replications

	MEAN				MEDIAN			
Sample Size	Observed	Bias	Std. Err	MSE	Observed	Bias	Std. Err.	MSE
430 (25%*)	-5.75	-0.002	0.234	0.055	-4.45	-0.027	0.264	0.070
860 (50%)	-5.75	-0.006	0.150	0.023	-4.45	-0.017	0.166	0.028
1291 (75%)	-5.75	-0.002	0.124	0.015	-4.45	-0.014	0.126	0.016
1721 (100%)	-5.75	-0.007	0.114	0.013	-4.45	-0.016	0.122	0.015

*Percentages are the sample size as a percentage of the original Baylor Survey Sample

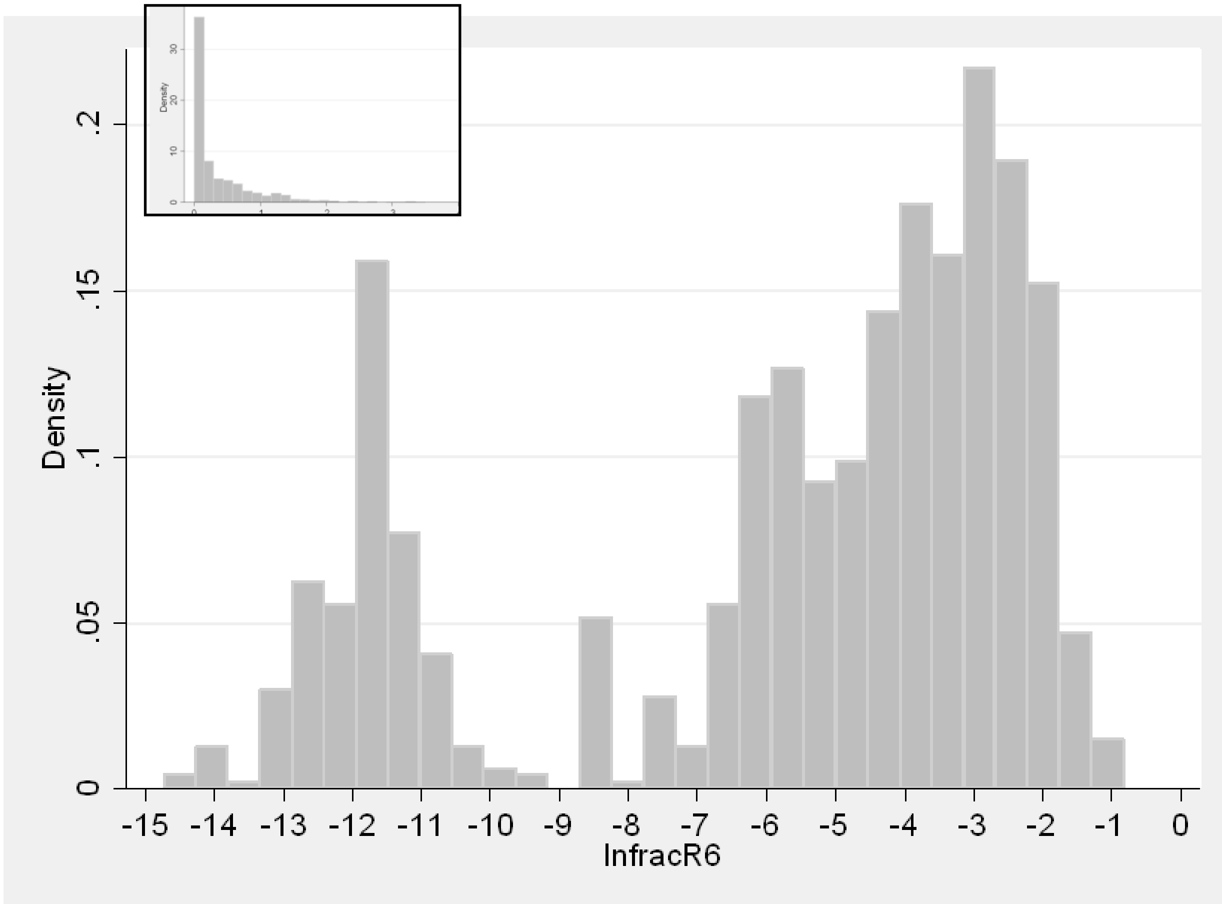


Figure 1. Baylor survey - Histogram of the fraction of full income dedicated to activities relevant to the religious congregation. N = 1,721

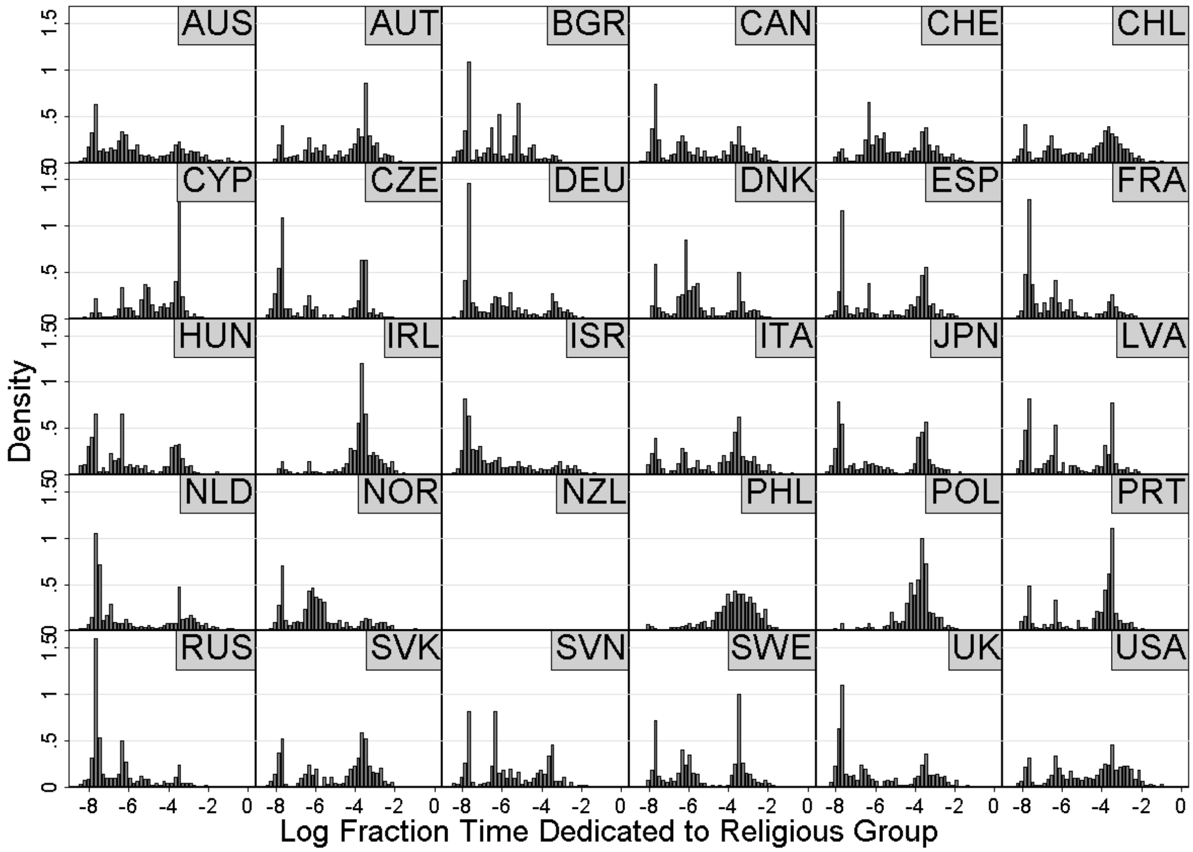


Figure 2. Density Histogram of Log Religious Fraction of Time by Country. Key: Australia (DNK) France (FRA) Germany (DEU) Hungary (HUN) Ireland (IRL) Israel (ISR) Italy (ITA) Japan (JPN) Latvia (LVA) Netherlands (NLD) New Zealand (NZL, excluded from figure) Norway (NOR) Philippines (PHL) Poland (POL)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

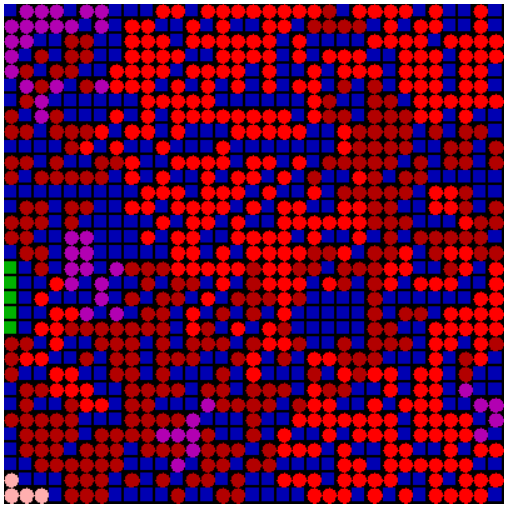
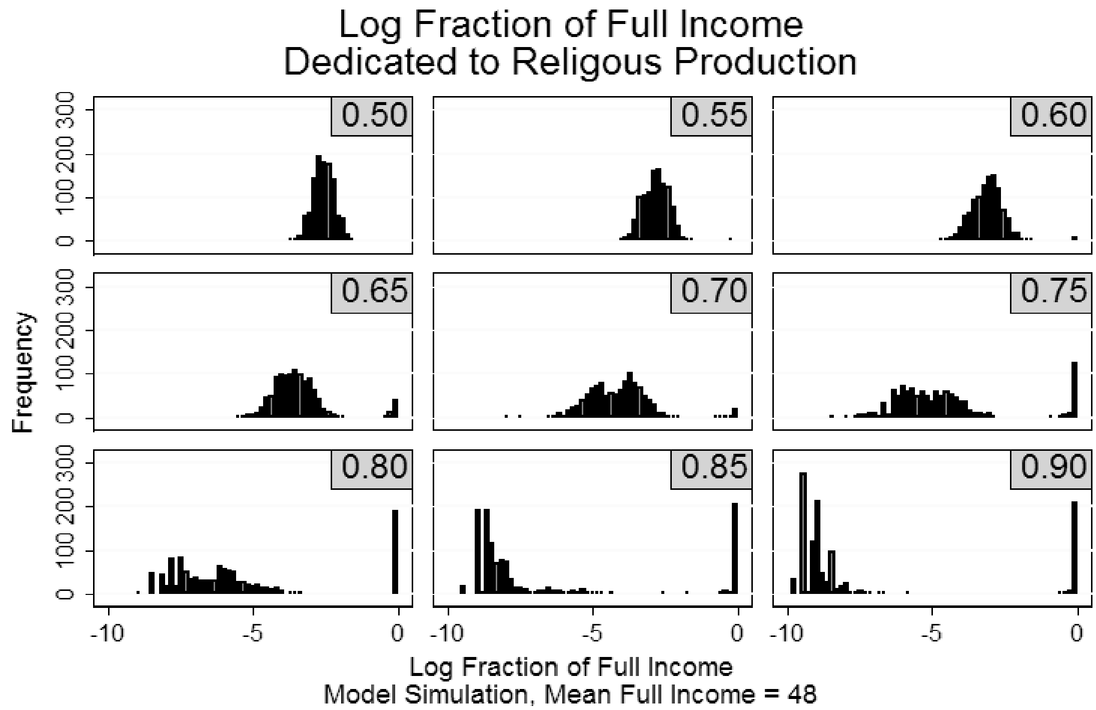


Figure 3 33 by 33 lattice



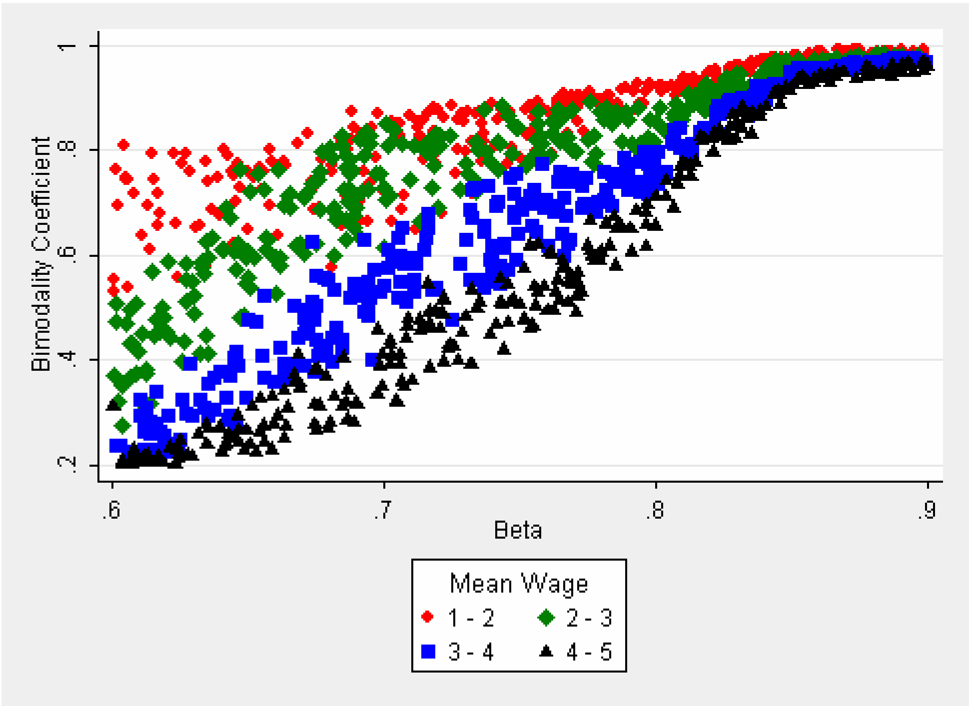


Fig 4(a) Histogram of Log Fraction of Full Income, Graphed by Beta (b) Median Bimodality coefficients of log religious time over beta, graphed by income. N = 120,000 (1,200 runs, 10,000 agents per run)

Appendix

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

Country	Bimodal (R_T)	Bimodal (R_F)	Mean (R_T)	Std Dev (R_T)	Skewness (R_T)	Kurtosis (R_T)
Australia	0.69	0.61	2.01	1.93	0.45	1.74
Austria	0.70	0.64	2.93	1.69	-0.60	1.95
Bulgaria	0.54	0.52	1.43	1.37	0.58	2.45
Canada	0.70	0.65	2.15	1.97	0.25	1.51
Chile	0.67	0.58	2.99	1.84	-0.47	1.82
Cyprus	0.64	0.61	2.84	1.44	-0.67	2.26
Czech Republic	0.83	0.78	1.93	1.96	0.25	1.28
Denmark	0.58	0.54	2.13	1.59	0.31	1.90
France	0.76	0.73	1.62	1.82	0.68	1.93
Germany	0.73	0.69	1.68	1.80	0.56	1.82
Hungary	0.68	0.63	2.08	1.74	0.16	1.50
Ireland	0.72	0.62	3.71	1.26	-1.76	5.68
Israel	0.79	0.72	1.32	1.83	1.05	2.65
Italy	0.68	0.58	3.06	1.79	-0.59	1.98
Japan	0.83	0.73	2.13	1.97	0.04	1.21
Latvia	0.73	0.67	2.11	1.83	0.09	1.38
Netherlands	0.86	0.74	1.77	2.07	0.44	1.39
New Zealand	0.65	N/A*	2.25	1.92	0.26	1.64
Norway	0.60	0.55	1.81	1.63	0.70	2.47
Philippines	0.59	0.49	3.87	1.27	-1.32	4.62
Poland	0.67	0.52	3.73	1.09	-1.97	7.25
Portugal	0.76	0.71	3.15	1.63	-0.95	2.50
Russia	0.78	0.72	1.12	1.51	1.12	2.90
Slovak Republic	0.71	0.69	2.91	1.86	-0.47	1.72
Slovenia	0.66	0.57	2.18	1.74	0.06	1.53
Spain	0.76	0.71	2.48	1.90	-0.26	1.40
Sweden	0.70	0.64	2.43	1.87	-0.04	1.42
Switzerland	0.53	0.49	2.65	1.51	-0.01	1.88
United Kingdom	0.76	0.75	2.40	2.04	-0.06	1.33
United States	0.64	0.55	3.05	1.87	-0.38	1.78

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