Religious Extremism, Clubs, and Civil Liberties: A Model of Religious Populations

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Abstract

This paper extends the club model of religion to better account for observed patterns of extremism. We adapt existing models to a multi-agent framework and analyze the distribution of agents and clubs. We find that extremism is more successful when religious groups are able to produce close substitutes for standard goods and that increased access to publicly provided goods can reduce the extremist population share. Quantile regression modeling of data from a multi-nation survey and institutional indices corresponds to the model's key results. Our findings offer a mechanism supporting research linking terrorist origination to civil liberties.

JEL Codes: C63, Z12, H56, D71

Keywords: Extremism, Religion, Sacrifice and Stigma, Multi-Agent Model, Civil Liberties

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I. Introduction

Religious extremism is as old as religion itself, but the tendency to promote militancy and terrorism from within extremist religions appears to be much more common now than in times past (Juergensmeyer 2001; Stern 2003; Wiktorowicz 2005).[1] Today's terrorists routinely frame their objectives in religious terms and organize their activities within religious movements. This shift is not due to increased militancy within religion as a whole, nor even within the stricter subset of religious groups commonly labeled "sectarian" or "fundamentalist" (Marty and Appleby 1995; Bromley and Melton 2002). Rather, groups with militant objectives are increasingly leveraging the latent potential for violence within extremist religion. Krueger and Maleckova (2003; 2007) have shown that, contrary to popular hypotheses regarding the salience of poverty and education, it is instead institutional conditions such as civil liberties that contribute to the origination of terrorists within a country. Religious extremism has been connected to terrorism, which has been connected to civil liberties. We seek to complete the triangle and connect religious extremism to social conditions, both theoretically and empirically, with an eye towards civil liberties.

This paper extends previous models of religious clubs to better account for observed patterns of extremism across different settings and test policies most likely to

[1] Following the work of contemporary sociologists and economists of religion, this paper defines religious extremism in terms of the high costs that a religious group imposes upon its members, especially those costs that arise due to deviant norms of conduct that limit the opportunities of members. Religious extremism cannot be defined apart from its social context. Greater extremism means greater difference, separation, and antagonism relative to the broader society and dominant culture. For more on this approach to extremism, see (Stark and Bainbridge 1985; Iannaccone 1999; Berman 2000; Stark and Finke 2000)

reduce the appeal of extremism. Economists, at first blush, should have trouble explaining the survival of groups that demand large sacrifices from their members. Successful religious groups, however, routinely impose all sorts of apparently unproductive costs on their members. Iannaccone (1992) introduced a formal model of religious clubs within which apparently irrational "sacrifice and stigma" enhances the individual and collective utility. His model demonstrated the feasibility of extremist groups, but does less to explain the relative prevalence of extremism across time and place. Further, the original model allows for only corner solutions, and as such, the viability of extreme groups is indistinguishable from the viability of the more moderate groups they must compete with for members in the religious marketplace.

In Section II we revisit, analyze, and extend the club model of religion. We push the analysis of the original model, exploring sacrifice, substitutability of club and private goods, and their relationships to member commitment and the viability of extremist groups. In this preliminary analysis, we illustrate both the potential insights of the club theory of religion into the strength and viability of extremist groups, but also the limitations inherent to the representative agent model. We proceed by extending the model in a multi-agent, computational framework. This framework permits us to analyze the distributions of agents and clubs that make up a religious economy. The computational nature of the model is critical because it allows for sufficient heterogeneity of agents and clubs, and given this heterogeneity, agent decision-making absent closed form solutions via Nash equilibria. Extremists groups emerge as just one segment (the high-cost tail) of a distribution of religious clubs that range across the full spectrum of potential (group-imposed) sacrifice and stigma. Extremism is identifiable and comparable in the model because it exists within a full spectrum of clubs. By varying the parameters of the model that control the distribution of (secular) wages across agents and the degree of substitutability between religious and secular commodities, we can better explain where and when religious extremism is most popular, its strength relative to more moderate groups, and which economic policies reduce its prevalence.

Although popular discourse tends to equate religious extremism and religious militancy, we must keep in mind that the vast majority of deviant religious groups have no history of violence (Iannaccone 1997). This paper uses the term “extremism” in the way it is now used by most sociologists and economists of religion. An “extremist” group requires its members to behave in ways that are very costly but not *directly* productive. Typical examples include restrictions on dress, diet, sexual conduct, and social interactions that limit opportunities or stigmatize members. Such groups also routinely insist that members contribute a great deal of their time and money to the group, most of which is not employed in ways that yield much marketable output. Hence, the costs and sacrifices in question are not mere transfers of resources from individual members to leaders or to the group as a whole.

The membership potential, as a fraction of the greater population, of groups demanding extreme levels of sacrifice on behalf its members remains unexplored. In representative agent models, which implement sacrifice as an increasing shadow price of secular goods, only two types of groups are viable: those requiring complete sacrifice (complete prohibition of secular goods) and those requiring zero sacrifice (full access to secular goods as priced by the market). A deeper understanding of group strength along a sacrifice spectrum necessitates the use of a distribution of agent wages. The multi-agent extension of the model allows agent wages to be randomly drawn from a generated probability distribution. The strength of any group type is measurable both relative to the sizes of other groups and as a fraction of the total population. Using the model, we can test the viability of extremism in the religious profile of a population of agents under different wage and substitutability regimes, where substitutability is the elasticity of substitution between the club good and secular goods. As a real world analogue, substitutability correlates with the ability of the group to produce goods internally that are substitutable for goods available in the private marketplace, via outside social networks, or provided publicly by government. Empirical research has established the substitutability of religious activity for both market (Gruber and Hungerman 2006) and state provided goods (Hungerman 2005).

We are constructing a model of extremism, and not terrorism. That said, our model is relevant to discussions of terrorist groups. As Berman (2004) has emphasized, costly religious extremism yields groups whose social characteristics (such as unusually high levels of mutual commitment) give them a comparative advantage in the production of terrorism relative to secular groups and mainstream religious groups. The key feature of Iannaccone's model is that sacrifice can mitigate free rider problems and thereby boost the production of club goods – including such goods as social capital, loyalty, and commitment. Sacrifice deters the entry of less committed members while also raising levels of involvement among those who do join the group. The net result is a social unit well suited to costly, high-risk activities (Iannaccone and Berman 2006). The more sacrifice a group can demand, the greater its *potential capacity* to sustain militant subgroups.

In our multi-agent model, substitutability is the key parameter governing model outcomes. For extremist groups to thrive, relatively lower wages are necessary[2], but not sufficient. Strong substitutability, however, is found to be necessary and weakly sufficient. Quantile regression analysis of simulation data generated by the model shows the agent response to substitutability changing from negative to positive as we move to the upper quantiles of the agent commitment distribution. When substitutability increases, the median agent reduces her commitment of resources to her club. The most committed agents in the population, however, respond in the opposite manner and commit more resources to their clubs as substitutability increases. Extremist groups, as such, will be more successful when they can provide a strong substitute for secular goods. Further, a simple extension of the multi-agent model finds that a publicly provided good similar to the club goods provided by organizations reduces the popularity of extremist groups within the simulated religious economy.

Quantile regression of religious commitment data from the 1998 International Social Survey Program results produces a negative to positive pattern of rising coefficients on civil liberties across quantiles similar to what is found in the regression analysis of the simulation data. This result holds when controlling for economic freedom and the quality of government produced public goods. The differential response to civil liberties across the commitment spectrum, specifically the increasing of religious commitment with weakening civil liberties at the extreme end of the commitment distribution, supports Krueger and Maleckova's (2003) work linking terrorist origination to weak civil liberties. The model offers a club mechanism within which the success of

[2] Necessary here meaning that population wages can be raised to levels, however unrealistic, at which extreme religion is suboptimal for even the poorest agents in the population, regardless of circumstance.

terrorist and extreme religious groups would correlate to civil liberties in a similar manner.

II. Modeling 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 is noteworthy that there is nothing uniquely religious in the construction. It does not employ any supernatural considerations, and is applicable to secular groups notable for their sacrifice and stigma requirements, such as military units or college fraternities. It remains, however, that club theory, and sacrifice and stigma specifically, has proven itself repeatedly as an effective and useful means of modeling religious congregations and the social phenomena associated with them.

In this section we revisit the original representative agent model and analyze some of its parameter relationships in greater depth than previous works before moving on to the multi-agent model. We construct the multi-agent computational model with mathematical underpinnings 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 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.

Agent utility production relies on secular and religious inputs, which are themselves produced by the agent using inputs of time and money. Time endowments are homogenous across agents, 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 can mitigate the free rider problem, resulting in rational members whose choose to reduce their secular productive capacity and, in turn, to engage in more religious production increases not just their own utility, but the utility of all other members.

The Representative Agent Model

In our model, as in Iannaccone's, utility is produced 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 here classic "Z-good" arguments in the utility function (Stigler and Becker 1977). *K* is produced by a Cobb-Douglas production function with constant returns to scale, with inputs of 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.

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

The group quality input, $Q_{i,g}$ 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. Here the original representative agent model hinges on a Nash-Equilibrium assumption ($\widetilde{R}_{j\neq i} = R_i$), creating a prisoner's dilemma. *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.

[2]
$$S_i = A_S (x_{i,S}^{a} v_{i,S}^{1-a})$$
$$R_i = A_R (x_{i,R}^{b} v_{i,R}^{1-b})$$

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.[3] 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.

From this Iannaccone (1992) derives Marshallian demands (R^e, S^e) with standard optimization.[4] Using these derived demands and shadow prices, and fixing several model parameters (w = 2; α = 0.3; a = 0.7; b = 0.3)[5] we can numerically explore the model beyond where Iannaccone left off. In Figure 1 we observe the U-shaped response curve of equilibrium agent utility over the secular productivity parameter A_S, where lower values of A_S correspond to greater sacrifice requirements. We include in Figure 1 the curves for differing values of β. The U-shape offers up two immediate properties. First, we can see Iannaccone's principal finding - the possibility of greater sacrifice (lower A_S) as the utility maximizing choice. Second, however, we take note that the utility optimizing choice is always one of the two corner solutions, where A_S is either zero (wherein agents choose to completely sacrifice all secular productivity) or one (wherein agent's do not sacrifice any productivity). This is not a concern in Iannaccone's paper, which serves as an existence proof of the possibility of utility enhancing sacrifice. In

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[3]
$$\pi_S = p_S\left(\partial x_S^* / \partial S\right) + w_i\left(\partial v_S^* / \partial S\right) = 1/A_S\left(p_S\left(aw_i/(1-a)p_S\right)^{1-a} + w_i\left(aw_i/(1-a)p_S\right)^{-a}\right)$$
$$\pi_R = p_R\left(\partial x_R^* / \partial S\right) + w_i\left(\partial v_R^* / \partial S\right) = 1/A_R\left(p_R\left(bw_i/(1-b)p_R\right)^{1-b} + w_i\left(bw_i/(1-b)p_R\right)^{-b}\right)$$

[4]
$$R^e = \left(\alpha^{1/(1-\beta)} \cdot \pi_R^{1/(\beta-1)} I\right) / \left(\pi_S^{\beta/(\beta-1)} + \left(\pi_R / \alpha^{1/\beta}\right)^{\beta/(\beta-1)}\right)$$
$$S^e = \left(\pi_S^{1/(\beta-1)} I\right) / \left(\pi_S^{\beta/(\beta-1)} + \left(\pi_R / \alpha^{1/\beta}\right)^{\beta/(\beta-1)}\right)$$

[5] These parameters are identical to those used by Iannaccone (1992) and are discussed in greater detail in the next section. The wage parameter is chosen in part for ease of visual depiction.

seeking to analyze extremist religion, however, this poses a greater problem. If only complete sacrifice is utility maximizing, then all successful religious clubs are extremist. Here we see the first limitation of the representative agent model. Extremism is a relative concept and is analytically tractable only when the model entails a wider spectrum of agent behavior and group sacrifice demands.

A third property within the representative agent model is observed by varying the substitutability (β) parameter. The shape of the response curve to A_S varies with β, flattening out with lower values. In Figure 1, with wages fixed we observe three different curves for three different values of β. The optimal corner solution varies with β. An agent with a given wage may choose very different clubs under different substitutability regimes. Under the current parameterization, we can see the "complete sacrifice" corner solution preferable under higher regimes of greater substitutability ($\beta = 0.9, 0.75$), and the "no sacrifice" solution preferable under weaker substitutability regimes ($\beta = 0.6$). We can infer from this finding that the recruiting success of clubs requiring complete sacrifice is increasing with greater substitutability of club goods for privately produced goods. Conversely, clubs requiring no sacrifice would be more successful in weak substitutability environments. Inferences regarding the impact on clubs occupying the intermediate are inconclusive.

[FIGURE 1]

We also want to know the impact of substitutability on agent contributions (commitment) to the group. It is only interesting, however, in the intermediate range of sacrifice. When clubs require complete sacrifice ($A_S = 0$), agents will contribute their entire full income to club production, regardless of substitutability. When clubs require zero sacrifice ($A_S = 1$), agents will easy-ride and contribute minimally to club production, with less regard to substitutability. It is only in the intermediate range that substitutability is potentially of interest. This is, again, problematic within the representative agent model, where only corner solutions are utility maximizing. For the moment it is useful to impose values of A_S exogenously, and observe the changing optimal contributions of agents. Using the same fixed parameters as earlier, Figure 2 shows the difference in equilibrium response to substitutability between clubs which allow secular productivity rates of $A_S = 0.1$ (90% sacrifice) and $A_S = 0.9$ (10% sacrifice). We observe sharply divergent responses to increasing rates of substitutability. The agents in the low sacrifice club are contributing less of their full income to group production as substitutability increases, while agents in the high sacrifice club are contributing more as substitutability increases.

[FIGURE 2]

We can infer from the relationships observed in Figures 1 and 2 that groups requiring extreme levels of sacrifice on behalf of members will be able to recruit a greater number of members and receive greater commitment of resources to the group by members as club goods become a stronger substitute for privately produced goods. Such inferences regarding extremist groups, however, are tenuous at best in a model in which *all* successful groups are extremist and the only alternative to joining an extremist group is to join a zero-sacrifice group crippled by free riders. We have no way of judging in the representative agent model how extremist groups will fare when competing with moderate groups (which in the real world constitute the majority of religious groups) or how they will respond to model parameters when they themselves are employing sacrifice requirements less than 100%.

The Multi-Agent Computational Model

To explore further the appeal of extremist groups and the commitment on behalf of their membership, we extend the model in a multi-agent (MA) computational context. The MA model retains all of the mathematical underpinnings of the original model except where explicitly noted. From these mathematical foundations, we extend the model in three key dimensions: population heterogeneity, time, and space. Specifically, the model is constructed with N heterogeneous agents, operating for T discrete time steps, on a two dimensional lattice (Figure 3), on which agents occupy spaces identified as "patches." Agents are one to a patch, and have a set of eight neighboring patches whose occupants make up their "neighborhood."

[FIGURE 3]

Agents are heterogeneous with respect to wage (w) and spatial location. As such, the original Nash Equilibrium assumption that $\widetilde{R}_{j \neq i} = R_i$ no longer necessarily holds true. In the MA model $Q_{i,g}$ is strictly increasing in n_g, with diminishing marginal returns.

[2] $$Q_{i,g} = \widetilde{R}_{g,j\neq i} \cdot s(1-1/(1+n_g))$$

This definition of $Q_{i,g}$ constitutes the most significant mathematical adaptation of the original model. Resultant of this adaptation the model ceases to have a closed form equilibrium solution.[6] In a computer-aided framework, however, we are less dependent on finding closed form solutions.[7] The utility function, for any given value of $Q_{i,g}$, is concave, containing only a global maximum. As such, we have the luxury of employing the relatively simple golden mean search optimization algorithm (Press 2002).

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:

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

The sacrifice that a group enforces comes at the expense of A_S^g, where the first group (*g* = 0) offers members private productivity parameter $A_S^0 = 1$ (no sacrifice) and the final group requires $A_S^{m-1} = \varepsilon$ (complete sacrifice, where ε is defined as an arbitrarily small value to prevent division by zero). The resultant sacrifice is $1 - A_S^g$.[8]

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[6] 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.
[7] The model is written in Java 1.5.1 using the MASON agent modeling library (Luke et al. 2005).
[8] 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.

Model Steps

Agents in the model spend their time looking around at the other agents in their neighborhood and hypothesizing what it would be like to join each of their respective groups. The agent then joins whichever group, as it currently stands, offers the highest potential utility at that time step. After joining a group, the agent then chooses the investment of her time and goods that optimizes her utility. 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 *m* 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 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.[9] 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

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

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 problem of, perhaps, surprising complexity for a model rooted in a standard CES structure. Despite this complexity, relying on a relatively small number of structural assumptions allows for a manageable number of parameters to be tested for their impact on the emergent landscape of groups.

Parameterization

We fix several parameters of the model exogenously for both tractability and functionality. 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 elasticities of demand 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 private production. Club goods require individual participation – *absentia* or proxy representation diminishes the good for both the agent and other group members.

The dominant strands in the income distribution literature suggest the lognormal, gamma, and exponential as the probability distributions that best describe the United States and other industrialized nations (McDonald and Ransom 1979; Majumder and

Chakravarty 1990; Dragulescu and Yakovenko 2001). For its tractability of generation and greater empirical accuracy at the lower end of the distribution, the 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).

Ceteris paribus, extremist group membership increases with greater returns to scale (s) in the production of the club good, but is not dependent on them. Members of extremist groups have a near complete dependence on the club good, and as returns to scale increase, so does the maximum utility the group can offer. None of the results discussed in this paper are dependent on a narrow parameterization of returns to scale. Sectarian groups with extremist demands will typically appeal only to a small subset of a population, at least early in its development, if not forever. Given these constraints on membership size, it is critical that the viability of extremist groups is not dependent on increasing, or even constant, returns to membership scale. Independence from scale is important given the military context that militant sectarian groups face. Organizations are often broken up into separate, self-sustaining cells whose objectives require small size. It is crucial that these clubs can thrive while membership is limited and exclusive.

III Simulation Results

Fixed parameters are constant across all model realizations: $s = 1.25$, $\alpha = 0.3$, $a = 0.7$, $b = 0.3$, $m = 60$.[10] Prices, preferences, and the log standard deviation of full income are all set equal to one. Substitutability, β, and mean full income, μ, are the key parameters tested. The experiment generating data for Figures 4 and 5 varies β in increments of 0.1, between 0.4 and 0.9, inclusive. Mean full income (μ) is varied in units of 8, between 8 and 64, inclusive. Each combination of β and μ is run 50 times, with 100 turns constituting a run. In the course of a turn, each of the 1,089 agents is activated in random order. When an agent is activated, she surveys her Moore neighborhood[11] and chooses the utility maximizing group.

We categorize four groups, out of the sixty possible, as being extremist, requiring sacrifices of 100%, 90%, 81%, and 73% of productive capacity.[12] We chart results for the set of β values 0.4 to 0.9 because sacrifice only feasibly offers utility improvements for members when $\beta > \alpha$ (see Iannaccone 1992). Operating within this subset is an assumption of the model justified by the simple intuition that a) agents' dependence on the club good for utility is not such that they are crippled without it, and b) that the value an agent receives from the club good is more dependent on the contributions of other members than her own personal contributions.[13]

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[10] These choices reflect the discussion in the previous sections. Results are robust to relatively small changes. Results remain the same with larger sets of groups (G), but testing is increasingly computationally burdensome.

[11] A Moore neighborhood is the eight spaces (agents) in the surrounding portion of the lattice.

[12] The selection of the top four groups (as opposed to three or five) is an arbitrary choice with the aim of being conservative in inclusion. The basic qualitative results are not sensitive to the range of groups selected.

[13] Values outside of this subset, while not outside of the realm of possibility, are unlikely. If $\beta < 0$, club influence over the agents reaches unrealistic levels - the arguments in the utility function, S and K, become multiplicative and denial of access to the club good reduces the agent's utility to zero. In a Z-good

Figure 4 presents a collection of charts with the fraction of the population in extremist groups over μ, with each panel representing a different value of β. Extremist groups are not viable when substitutability between club goods and private goods is insufficiently strong ($\beta \leq 0.5$). Below the β threshold, the relative weaker substitutability of goods makes the specialization in the club good required by extreme groups suboptimal for all agents across the full range of μ tested. Extremists as a percent of the population are always declining with the mean full income of the population, regardless of substitutability. Using the same data, Figure 5 presents a collection of charts with β as the independent variable, with each panel representing a different value of μ. For every value of μ charted, the fraction of the population joining extremist groups is increasing, at a decreasing rate, with β.

[FIGURE 4]

[FIGURE 5]

Quantile Regression Modeling of Generated Data

Quantile regression is generally presented as a tool for dealing with issues of robustness rather than theory (Koenker and Bassett 1978). Hamermesh (2000), however, eloquently points out that while quantile regression is advisable under conditions when

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structured model with sufficient complementarity of arguments in the utility function, being denied any one Z-good is equivalent to a death sentence or rational suicide (Levy 1982). Values of β in the intermediate range $0 < \beta < \alpha$ are unlikely as well; rising values of α correspond to increased output elasticity of the K to the individual's inputs and decreasing importance of the group's. Marginalizing the role of other members in the club good is antithetical to the concept of a religious congregational good.

the mean may not be a robust estimator, it can also be an effective tool for modeling data where economic theory makes different predictions for distinct quantiles of the distribution of the dependent variable (see also Buchinsky 1998; Koenker and Hallock 2001; Levin 2001).[14] Any theoretical model employing interacting heterogeneous agents promises the possibility of differential responses to model parameters across subsets of agents. Agent decisions are dependent on the interactions of other agents. This complexity invites the possibility of varied responses. Further, the model is motivated, in part, by the limitations of representative agent constructs when dealing with a subject, such as religious extremism, where the critical agents are not those from the middle of the population distribution, but those found in the tails. Given this complexity, and our analysis of the representative agent model in Section II (see Figure 2), we hypothesize that individuals distinguished by their large religious commitments (the upper quantiles of the commitment distribution) will respond to their institutional settings differently than their moderate counterparts. Regression analysis of the conditional quantiles is ideal for testing this hypothesis. Contrary to more common analysis of empirical data, the merits of regression analysis of simulation generated data are not in uncovering which tested factors matter (given the simple theoretical construct, we would expect any varied parameter to be statistically significant). Rather, regressions of the simulation data offer a better understanding of the magnitude and shape of how the outcome variables respond to parameters across the differing conditional quantiles. Further, results can be compared to similar quantile regression models of related empirical data. Quantile regression, as

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[14] "Useful features of the quantile regression and censored quantile regression models can be summarized as follows: ......, (e) potentially different solutions at distinct quantiles may be interpreted as differences in the response of the dependent variable to the changes in the regressors at various points in the conditional distribution of the dependent variable; ....." page 89, Buchinsky (1998).

opposed to standard OLS, is particularly useful in this context given the use of a distribution of heterogeneous agents choosing from a distribution of heterogeneous groups, as well as our specific interest in understanding what distinguishes the “extreme” tail of the distribution.

Data was generated from 500 runs of the model, each for 100 turns, with mean population full income [8, 64] and substitutability [0.4, 0.98] pulled from random uniform distributions. The generated data is analyzed with the log-log conditional quantile regression model:

$$\begin{aligned} &\log \text{fracFI}_\text{i} = \phi_0 + \phi_{1\theta} \log \beta + \phi_{2\theta} \log \text{Full Income}_\text{i} + \nu_\theta \\ &\text{with Quant}_\theta (\log \text{fracFI}_\text{i} \,|\, x_i) = x_i' \phi_\theta \end{aligned} \quad [4]$$

where fracFI$_\text{i}$ $= \pi_R R_i / \left(\pi_S S_i + \pi_R R_i \right)$, the fraction of full income dedicated to club production by agent *i*.

To restate, we are testing how the conditional quantiles of fracFI$_\text{i}$ respond to changes in the simulation variables, substitutability (β) and full income (μ). Table 1 shows the regressor coefficients for the 30% through 95% conditional quantiles of fracFI$_\text{i}$, as well as the corresponding OLS results. Figure 6 presents the coefficients for the substitutability regressor in smaller increments. In Table 1 and Figure 6 we can see that fracFI$_\text{i}$ is decreasing with substitutability (β) in the lower quantiles, but increasing with substitutability after the 80% conditional quantile. The more moderately committed agents in a population will contribute more to their groups when they can offer a weak complement. The most committed members of a population (extremists, if you will) respond in the opposite manner, contributing more to their groups when they can offer a strong substitute for private production. The changing of the coefficient from negative to positive is an example of a population dynamic that likely would go unnoticed with traditional OLS analysis, which reports only a positive coefficient (Table 1, column 1), an example of the merits of analyzing the conditional quantiles of data generated by multi-agent models. The coefficient of full income is negative across all quantiles; increasing opportunity cost of time uniformly decreases dedication of resources to time-intensive club production.

[TABLE 1]

[FIGURE 6]

The mechanics of this outcome are derivative of two structural elements of the model: utility production with two inputs and agent wage heterogeneity. Crudely put, in a two-input model, greater substitutability allows for greater specialization in a single input, which is exactly what an extremist group demands (see Figure 2, $A_S = 0.1$). Complementarity, conversely, rewards utility production using a more even mixture of inputs and makes severe free riding less attractive. Such conditions are more conducive to moderate groups, within which agents can more efficiently pursue both club and secular endeavors (see Figure 2, $A_S = 0.9$).

The relevance of agent heterogeneity in this context is a bit more complicated and relates to the previous point regarding specialization. Heterogeneity exacerbates the free rider problem when substitutability is high. The more troublesome the free rider problem, the more attractive extremist groups will be. Conversely, when substitutability is weak, heterogeneity softens the free rider problem, which allows moderate groups to thrive. In a heterogeneous population, agents who earn lower wages place a greater fraction of their productive capacity into time intensive religious endeavors from which other group members benefit. As such, every agent has incentive to find a group whose members are relatively poorer than she is. High wage agents will always want low wage agents in their clubs because their specialization in time intensive activities add to the quality of club goods they benefit from. Lower wage agents, however, will be wary of having the quality of the club good weakened by free riding high wage agents. Moderate sacrifice requirements commit high wage agents to a level of club contribution sufficient to make the group attractive to low wage agents. As substitutability increases, high wage agents will find moderate sacrifice less attractive, and move towards zero sacrifice groups within which they can specialize in private (secular) production. At the same time, lower wage earners will have greater incentive to move towards extremist groups whose higher sacrifice requirements will screen out higher wage agents likely to free ride. Substitutability effectively cleaves the population. Greater substitutability will push moderate groups towards less club production, and extreme groups towards more club production (see Figure 6).

As β decreases, the substitutability of the two goods weakens and their complementarity strengthens. The minimum amount of club production by the high wage agent increases as the efficient production of utility is dependent on increasingly more equitable amounts of its two "Z-good" inputs. The high wage agent stands to gain more from the inclusion of club good in her utility production as the complementarity of S_i and K_i increases. As a result, the marginal reward to the poorer individual's contribution is less burdened by the free riding of wealthier members as β decreases. Weaker substitutability makes high wage agents more amenable to club production and low wage agents more amenable to lower sacrifice requirements, both of which lead to greater commitment in non-extremist groups.

Further, in a heterogeneous population, higher wage agents have greater financial resources and equivalent time resources to lower wage agents, giving them an absolute advantage in productive capacity. When religious and secular utility inputs are sufficiently complementary, lower sacrifice groups can become attractive to lower wage agents who seek to benefit from the absolute productive advantage enjoyed by higher wage co-members. Whereas heterogeneity encouraged high wage agents to free ride when inputs were strong substitutes, increasing the appeal of extremism, when they are weak complements heterogeneity instead encourages low wage agents to seek out moderate groups attractive to high wage agents.

IV Application: Testing Proposed Policy

> "…the policy implication of this analysis is that an efficient economy and a secular state providing public goods both weaken religious sects as members become less desperate for the economic services these sects provide." – Eli Berman, *Hamas, Taliban and the Jewish Underground: An Economist's View of Radical Religious Militias* (2004)

There is within Iannaccone's and Berman's work the implicit and explicit policy proposition that goods competitive with the club goods provided by extremist groups should be subsidized or protected in an effort to reduce the attractiveness of these groups to existing and prospective members. Berman (2004), via Munson (2001), tells the story of President Nasser's nationalization of the Muslim Brotherhood's social welfare network in Egypt, and the subsequent decline in both terrorist and non-violent activity by the Brotherhood. Such stories portend well for the potential effectiveness of targeted public goods policies. We adapt the model to test this proposition. Agents continue to produce their utility with inputs of private and club goods. The club good, however, is now supplemented with an impure public good that is available to all members of the population at zero price, but is subject to the sacrifice requirements of the group.[15] This good is publicly provided such that no agent is excluded, and acts (for the sake of our argument) as an input to the club good portion of agent utility production, but can be reduced in consumable quantity by an agent's club sacrifice requirements. A possible real world example would be a public school system. School systems are a good example because they are often a bundle of goods that include not just educational instruction, but also access to a variety of social networks for students and families. Religious clubs often offer members access to club schools that are very attractive to prospective members. A government could provide a competing school system, offering a similar bundle of human and social capital goods. Clubs with high sacrifice requirements, in turn, could limit access to this good through a variety of sacrifice and stigma requirements, including alternative holidays, required prayer times, manner of dress, gender limitations, exclusion of reading materials, and limits to social interaction.[16] In this exercise we augment the

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[15] While the good is costlessly accessibly to all agents, it is *impurely*-public because the club is able to partially exclude its members from its consumption through sacrifice requirements.
[16] Of course prohibiting attendance of public schools would approach 100% sacrifice of this publicly provided good.

club good $Q_{i,g}$ with an additional argument Ω that is subject to the group sacrifice rate, 1 - A_S.

[4] $$Q_{i,g} = \widetilde{R}_{g,j\neq i} \cdot s(1-1/(1+n_g)) + A_S\Omega \quad \{\Omega \geq 0\}$$

[FIGURE 7]

Results reported in Figure 7 support the policy proposition. Increasing provision of a public good Ω reduces the appeal of extremist groups to prospective members. Agents who were previously a part of the extremist tail of the distribution have shifted to *relatively* moderate groups. Further, there is no increase in the most moderate portion of the distribution – the public good provision has not reduced the appeal of all sacrifice requiring groups, only the most extreme.

Whether the new public good in the model, Ω, reduces the attractiveness of extremist groups to potential members is dependent on whether it is subject to group sacrifice. If group members have equal access to the public good, regardless of sacrifice level (i.e. if A_S is dropped out of Equation 6), then there is *no impact* on the distribution of groups. Without sacrifice of public good Ω, Figure 7 remains unchanged from panel 0 as Ω is increased. If the public good is subject to group sacrifice, then there exists both an income effect and a substitution effect between the private and club goods as Ω increased. Offering to individuals a public good at zero price that is *not* subject to the group sacrifice affects individual decision-making only through a potential income effect, changing the absolute wealth of all agents uniformly, but not changing the shadow prices of private and club production. The observed income effect in these simulations is approximating zero. The substitution effect, derivative of a higher opportunity cost of membership, drives the resulting shift away from extremism in the population. This suggests that policies of general aid to the population to increase wealth, while possibly valuable in any number of ways, are less likely to reduce the appeal of extremism.

The necessity of public good subjection to group sacrifice is not, necessarily, detrimental to the aims of the policy; it may even enhance the effect. Extreme groups are more likely to inhibit member access to the public good. Further, extremist groups who are violent in nature are likely to self-select from accessing the good, as their reputation for violence will make entering the public sphere a potentially high cost endeavor. It is feasible that offering public goods similar in nature to the club goods produced by religious extremists will disproportionally reduce the attractiveness of criminal groups, leaving peaceful, law-abiding extremist groups less affected. The exact nature of the public good is indeterminate in this analysis, but candidates would likely resemble those offered by groups such as Hamas, which include schools, orphanages, mosques, healthcare clinics, soup kitchens, and even sports leagues (Levitt 2004).

V Data on Religious Commitment

Krueger and Maleckova (2003) find that terrorists from a country positively correlate with deteriorating civil liberties and that when civil liberties are controlled for, the relative wealth of the country and its literacy rate have no statistically significant effect. These results run counter to the conventional wisdom that poverty and ignorance are the root causes of terrorism. There has not been much in the way of theory to explain why weak civil liberties would be an important input into terrorist production (or, similarly, why strong civil liberties would be an obstacle to terrorist production). Civil liberties signal the existence of strong and healthy political and social institutions, particularly those relating to the ability of individuals to interact and congregate in meaningful associations. In countries with strong civil liberties we would expect private associations more numerous and robust, the marketplace more likely to thrive, and the state less coercive and more trustworthy as a provider of public goods. One possible explanation of the impact of civil liberties is that terrorists organized as an extremist religious group can offer a stronger *substitute for* secular alternatives when and where civil liberties are weak. As they are able to offer a stronger substitute, they will be able to recruit more members and induce greater commitment on behalf of their membership. If such a mechanism were at work, then it should be observable not just in the violent manifestations of extremist groups, but in the religious commitment of populations which would, across their quantiles, correlate to civil liberties similar to what is observed in our model. Further, as we go to the higher quantiles of religious commitment, we would expect a sign switch, with the most committed people increasing in commitment with weaker civil liberties.

Similar arguments can be made regarding related institutional conditions and the substitutability of religious club goods for secular goods. The rational group will only position its club good as a substitute if it can hope to compete with the amalgamated offer of all other goods. If the public sector offers equivalent goods at a lower price, the group will be more attractive to prospective members if it structures, and markets, its club good as more of a complement. As the marketplace grows in size, so does the variety of goods it offers. The group may still desire to position itself as a substitute, but it simply cannot produce such a good internally – the group is limited by its internal division of labor. Healthy markets institutions effectively cap the degree of substitutability a club good can achieve. Similarly, effective government can provide public goods with a reach and scale difficult for any group, again limited by its size and internal division of labor, for which to provide substitutes. Under such circumstances, citizens are less likely to look to club goods for substitutes, and more likely to look to them for complements, for the goods and services they procure independently. This logic implies that substitutability of club goods for non-club goods will decrease as market and government institutions get stronger. We hypothesize that the distribution of individual religious commitment will correlate to institutional indices in a manner analogous to the correlation between religious club commitment and substitutability in the theoretical model. We predict that moderate religious commitment will grow when social institutions are strong, while, as said earlier, more extreme commitment will grow when social institutions are weak.

To test our predictions, we construct a quantile regression model of survey data from the 1998 International Social Survey Program (Religion II), which included questions regarding respondent time commitments to religious activities and their yearly earnings. Sufficient data was available from 25,806 respondents from thirty countries.[17] We model the relationship between religious time commitment and institutions with the following conditional quantile specification:

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[17] The data used here are a summation of respondent choices from a set of cardinal values. The resulting measure of time commitment to his or her religious group has 216 possible outcomes. The largest time commitment attributable to an individual by our summation is 323 hours. Unfortunately, we are unable to more finely distinguish individuals at the highest level of commitment in the sample.

[5]

$$\log z_{ij} = \alpha_0 + \alpha_{1\theta}\log \text{Institutions}_{\text{j}} + \alpha_{2\theta}\log \text{Earnings}_{\text{i}} + \alpha_{\theta 3}RR_j + \mu_{\theta ij}$$
$$\text{with Quant}_\theta(\log z_{ij} \mid x_{ij}) = x'_{ij}\alpha_\theta$$

z_{ij} is the log of hours dedicated to religious group activity in the last year by respondent *i* from country *j*. **Institutions** includes the civil liberties index (as reported by Freedom House), economic freedom index (as reported by The Heritage Foundation), and the World Bank's government effectiveness indicator (Kaufmann et al. 2005) for country *j*. We use all three indices here in reverse scales: increasing values report deteriorating institutions. **Earnings** is the individual earnings for the previous year reported by respondent *i*. The role of religious regulation has been established empirically (Grim and Finke 2006) and theoretically (Barros and Garoupa 2002). All specifications include the index of religious regulation controls, *RR*, in country *j*, constructed by Grim and Finke (2006) The data used is summarized in Table 2.[18] A table of countries and institutional indices are included as an appendix. To account issues of robustness and correlation across observations within countries, we bootstrap the regressions to allow standard error clustering by country.

[TABLE 2]

[18] To avoid exclusion of zero religious time observations, an "approximate log" transformation was used, adding ε =1 to the values of religious time. Box-Cox estimation of all three specification variations yield a lambda = 0.01.The qualitative results of the analysis remain the same with ε = 0.001. Retaining the original values and estimating the level-log produced coefficients with identical signs. For a discussion of the potential bias involved with approximate log estimates, see Ehrlich and Liu (1999).

The coefficients of the institutional and income survey variable quantiles are reported in Table 3. Figure 8 presents the coefficients for the civil liberties regressor in smaller increments, as well as the 95% confidence interval. Limitations on the range of countries and number of individuals surveyed resulted in data that is likely under-representative of individual religious commitment in the upper range. As such, the individual quantiles should not be interpreted as corresponding to the identical quantile from the simulation data. Rather, we are looking for corresponding negative coefficients at the lower ranges of religious commitment and similar transitional effects as we move to higher quantiles.[19] While there are positive correlations between civil liberties, economic freedom, and government effectiveness, they remain sufficiently different to test them together.

Religious time commitment decreases with deteriorating civil liberties in the lower quantiles, and transitions to a positive response to deteriorating liberties in the upper quantiles (Figure 8, Table 3). The coefficient on civil liberties becomes larger with each higher quantile, moving from -0.973 (10% quantile) to 0.128 (95% quantile). The civil liberties index is the only variable that switches directions in its impact on religious commitment across quantiles. Most coefficients are not statistically significant at the 5% level, though the 95% confidence intervals are shrinking as we move up to the higher conditional quantiles.

Religious time commitment is decreasing with reduced economic freedom across all quantiles. The magnitude of the negative response to reduced economic freedom in the data is U-shaped, with largest reduction in religious time commitment correlated to

[19] Given the simplicity of the model, that the quantiles do transition at similar points cannot be interpreted as more than coincidence at this point.

weaker economic freedom in the middle quantiles, and relatively smaller correlations in the higher and lower quantiles. A transition to a positive effect is not observed.

It is possible that civil liberties act as a proxy for the quality of government provided public goods, whereby governments with poor public goods must resort to coercion to engender legitimacy. This might explain why extremist groups would thrive when government services qua civil liberties are weak, though it does not explain why moderate groups enjoy greater member commitment when civil liberties are strong. We address this by including the World Bank’s indicator of government effectiveness. This indicator serves to measure the quality of public goods produced by government and the efficiency with which it produces them. Hungerman finds evidence that government and churches are substitutes (Hungerman 2005). Supporting the church as government substitute hypothesis and Hungerman’s results, we find that religious time commitment is here increasing with weakening government effectiveness across all of the quantiles.

Religious time commitment is declining with earnings in every specification, across every quantile. The absolute magnitudes of the coefficients, however, are shrinking at the higher quantiles, indicating the religious time commitments of the most religiously committed individuals are less sensitive to their earnings than their more moderate counterparts. This is possibly because members of moderate groups tend to have higher incomes, and in turn, higher opportunity costs of time, and are more likely to substitute financial contributions for donations of time as their incomes rise. Religious time commitment is decreasing with religious regulation across all quantiles and specifications.[20]

[TABLE 3]

[FIGURE 8]

VI Discussion

The model is of groups that are neither necessarily religious nor militant. Groups that place large demands of sacrifice upon its members have been identified as "extremist." These groups are defined by internal mechanisms for member incentive alignment that are congruent with terrorist tactics, and are relevant to discussion of the characteristics that underpin potential hotbeds of militancy. Extremist groups decrease in size in the model as wages rise; it is possible for wages in the simulated population to reach a level wherein extremism is no longer appealing to anyone. The impact of poverty, however, is dependent on the substitutability of the club produced Z-good for the privately produced Z-good; strong substitutability is (weakly) sufficient for the viability of extremism (within a reasonable range of wage distributions). Pure income effects, such as a windfall gain or universally received lump sum aid, have no effect on the extremism profile of a population in the model.

The correlation of upper tail of the commitment distribution in the ISSP survey to civil liberties offers a mechanism to underpin and clarify Krueger and Maleckova's

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[20] The theoretical model reports religious commitment universally decreasing with wages, but the similar result found in the survey is potentially an artifact of high wage individuals substituting money for time. The 1998 ISSP data does not report financial contributions; substitution of money for time is unseen.

finding of terrorist origination increasing with the deterioration of civil liberties. Terrorist groups, even if not explicitly organized as an extremist religious group, use similar sacrifice mechanisms, and we can expect them to respond to institutional conditions in a manner similar to extremist religion. Further, the corresponding patterns of changing coefficients across quantiles for the substitutability variable in the simulation data and the civil liberties variable in the survey data offer up a potential theoretical mechanism by which civil liberties impacts terrorist organizations. If we interpret civil liberties as a proxy for increased prevalence and accessibility of well-working social institutions, then we can equate improving institutions with reducing the prospects of a group to offer a strong substitute for the state and private marketplace. Controlling for civil liberties, economic freedom, and government effectiveness, only civil liberties exhibits the changing of correlation from negative to positive across the distribution similar to that observed with substitutability in the simulation model. This is suggestive of the importance of factors unique to civil liberties (versus those overlapping with economic freedom and government effectiveness), such as assembly, association, and social networks. Extremist groups requiring high sacrifice are more attractive when more mundane, moderate groups are prohibitively difficult to organize, something we would expect under conditions of weak civil liberties. The degraded quality of standard social goods under conditions of weak civil liberties lowers the bar for extremist groups in their efforts to offer a club good as a strong substitute for outside offerings.

The across the board empirical and theoretical findings of religious commitment decreasing with earnings appears an elementary case of individuals facing rising opportunity cost of time, where club production is more time intensive than private production.

VII Conclusions

We find that religious commitment generally, and religious extremism in particular, correlates to civil liberties empirically in a manner similar to how commitment correlates to substitutability of club goods and private goods theoretically. Given that religious extremism is a frequent, and important, input into terrorism, this suggests a mechanism behind the Krueger and Maleckova (2003) results linking terrorist origination to weak civil liberties that relates to the organizing of such groups as religious clubs and the use of sacrifice and stigma to engender commitment.

The policy proposition for public goods to undermine extremist groups is found promising, so long as access to the public good is subject to group sacrifice requirements. This caveat is unlikely to be violated, however, in light of groups' underlying incentives to use sacrifice to screen out free riders. Further, barriers to goods provided through governments, aid organizations, and the marketplace are likely the strongest for groups operating outside the law. Members of groups associated with violence have strong incentives to maintain a closed network of social interactions. The most difficult hurdle to effective policy under these conditions would not appear to be diligence in supervision of public good provision, but rather the supporting of public goods and markets that directly compete with the club goods extremist organizations produce to attract members.

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FIGURES

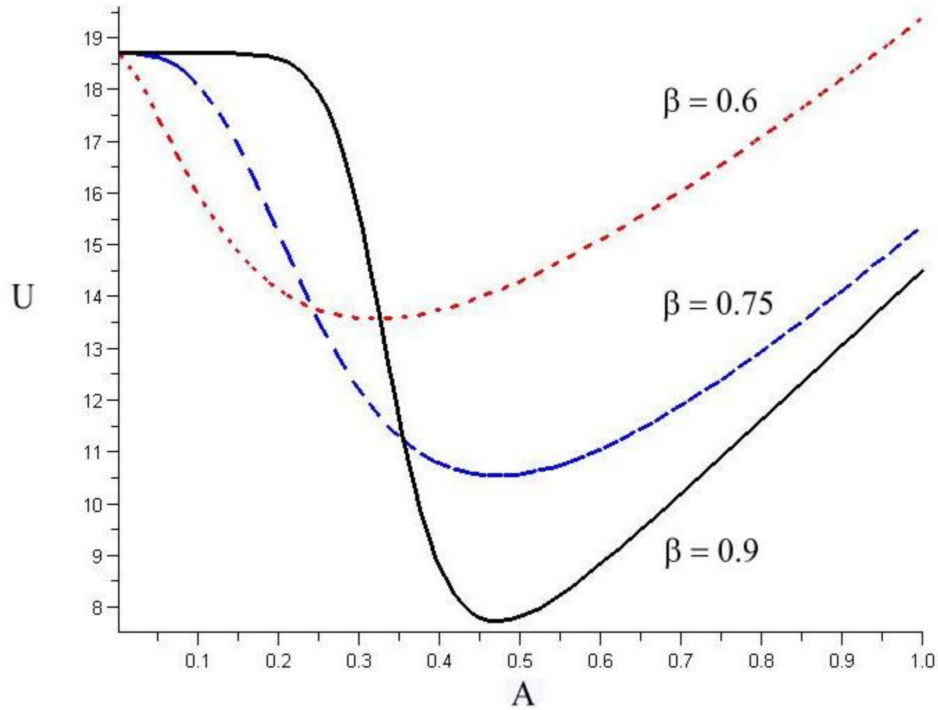

Figure 1. Equilibrium Agent Utility over A_S in the representative agent model. Outcomes for three different values of β (0.6, 0.75, and 0.9) are shown.

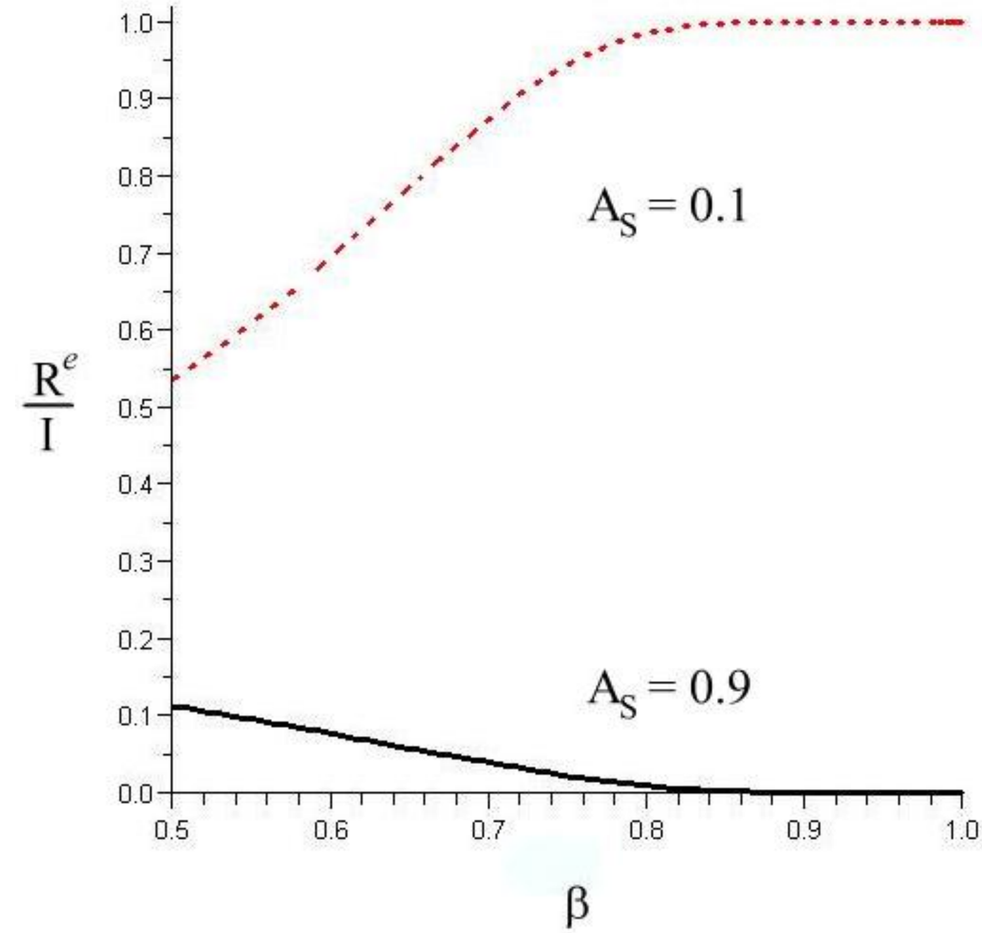

Figure 2. Equilibrium fraction of full income dedicated to the religious club (R^e / I) over substitutability (β) in the representative agent model. Outcomes for two different values of A_S (0.9, 0.1) are shown.

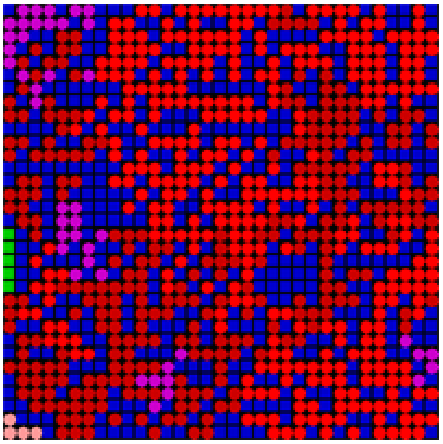

Figure 3. 33 by 33 lattice

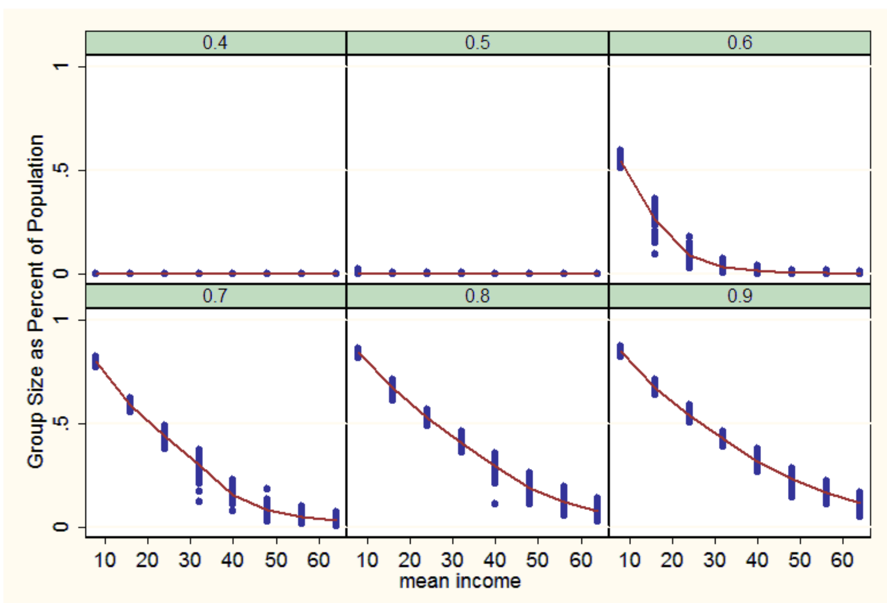

Figure 4. Extremist groups as a percent of the population over mean full income (μ) with substitutability (β), varying across panels. The value above each panel is the substitutability parameter (β) for the set of simulation runs graphed within the panel. Mean full income μ varies along the x axis within each panel. Extremist group members, as a percent of the simulated population, is measured on the y axis.

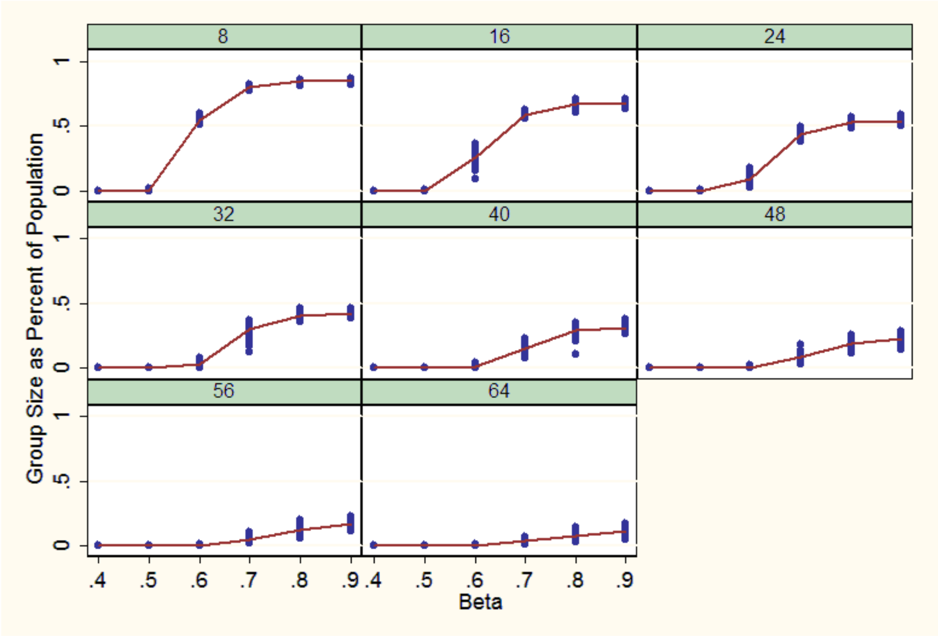

Figure 5. Extremist groups as a percent of the population over substitutability (β), with mean fill incomes varying across panels. The value above each panel is the mean full income of the wage distribution for the set of simulation runs within the panel. β varies along the x axis within each panel. Extremist group members, as a percent of the simulated population, is measured on the y axis.

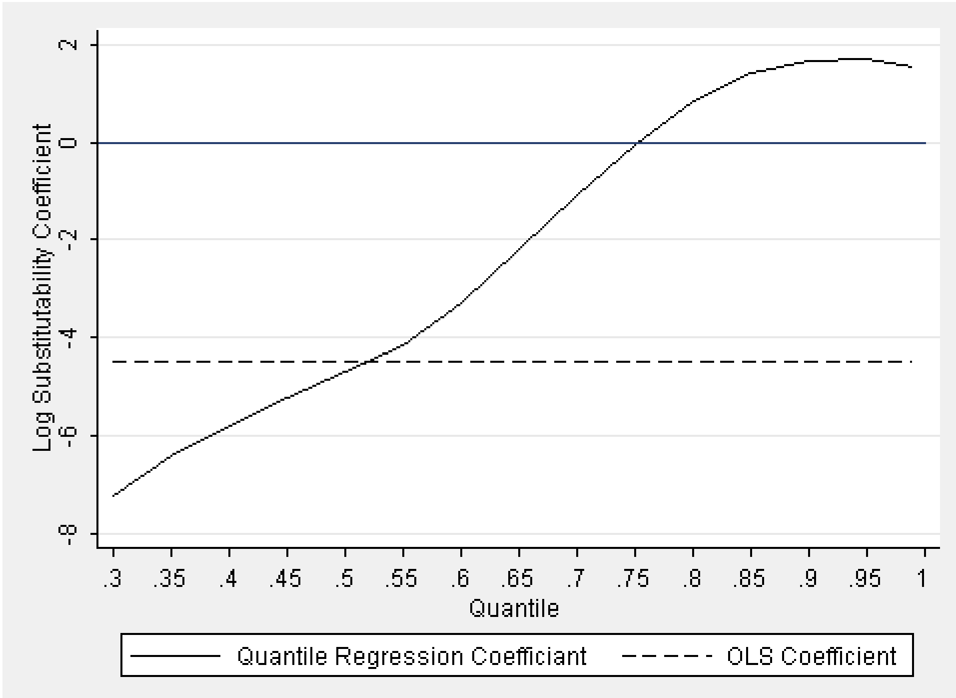

Figure 6 Quantile Regression Coefficients between 30% and 99% quantiles in increments of 5% (99% charted instead of 100%), simulation generated data. Conditional quantiles: Log Full Income Dedicated to Club Production. Regressor: Log Substitutability.

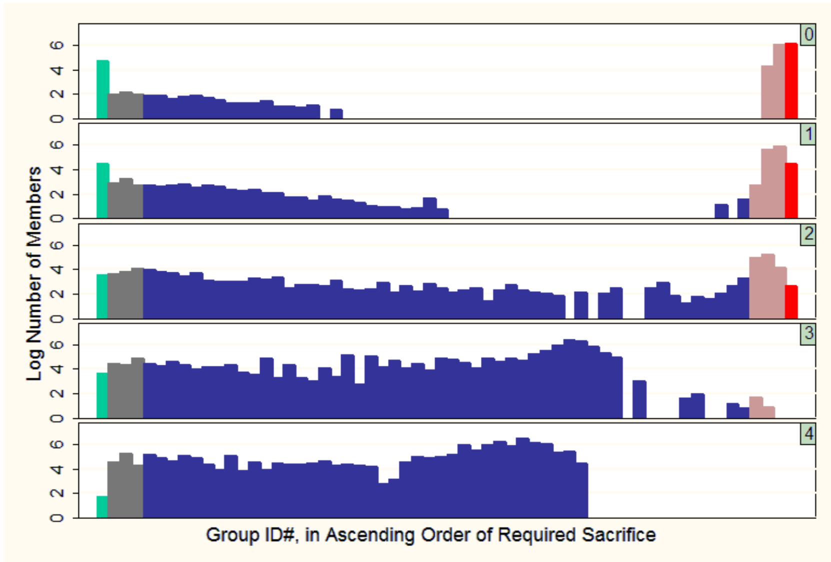

Figure 7 Log Group membership, graphed by public good Ω (indexed in the upper right corner). Group ID # *m*, and in turn the amount of sacrifice required by the group, is increasing as we move to the right on the horizontal axis, with each bar representing a different group. The vertical axis measures log(n_g). The groups labeled "extreme" have been color-coded shades of red. The quantity of of public good Ω made available is increasing as we move down the charts. At the highest amount of Ω available extreme sacrifice groups fail to recruit members.

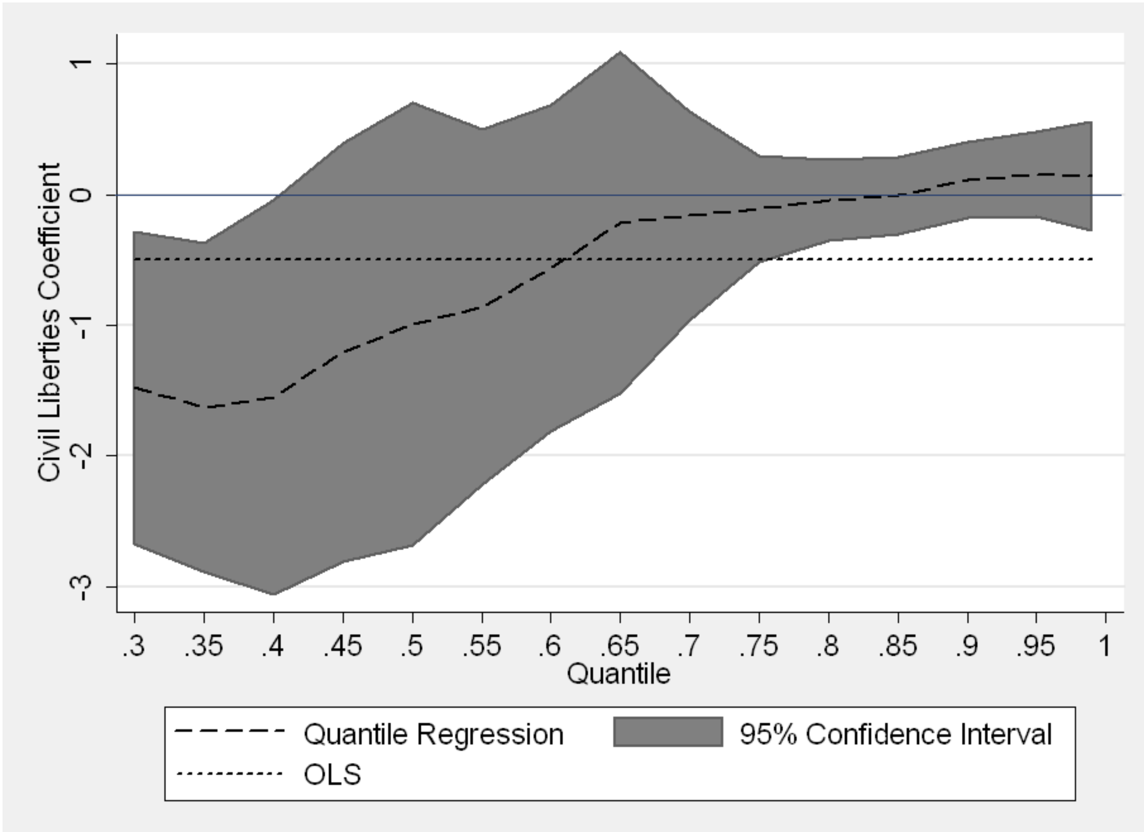

Figure 8 Regression Coefficients between 30% and 99% in increments of 5% (99% charted instead of 100%), 1998 ISSP Religious commitment data. Conditional quantiles: Log Religion Time. Regressor: Log Civil Liberties.

TABLES

Table 1. Quantile Regression Estimates: Fraction Log Full Income Dedicated to Club Production

		Quantile						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	OLS	30%	40%	50%	60%	70%	80%	90%
Log Substitutability (β)	-4.483	-7.243	-5.796	-4.694	-3.292	-1.081	0.867	1.690
	(0.011)	(0.016)	(0.010)	(0.007)	(0.010)	(0.013)	(0.011)	(0.007)
Log Mean Full Income	-1.499	-0.880	-0.994	-1.005	-1.213	-1.309	-1.035	-0.782
(μ)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.001)
Constant	-0.933	-5.140	-3.487	-2.554	-0.836	1.192	1.949	2.048
	(0.009)	(0.010)	(0.007)	(0.006)	(0.009)	(0.013)	(0.010)	(0.006)

N = 544,500. SE in parentheses. All coefficients significant at 0.1% level.

Table 2. Summary Statistics, Survey and Institutions

Variable	Mean	Std. Dev.
Religious Time[†]	37.65	54.26
Earnings[†]	13,963	16125
Civil Liberties [ŧ]	1.71	0.73
Economic Freedom[§]	33.41	9.31
Government Effectiveness[‡]	1.70	0.87
Religious Regulation[‡‡]	1.78	2.12

N=25,806 observations † International Social Survey Programme 1998: Religion II (ISSP 1998), Yearly earnings reported in the data set as median values from survey ranges unique to each country and converted to 1998 dollars. Religious hours per hour are a sum of intermediate values from three different survey questions, ŧ Freedom House (2005): Scale 1-7, low is better civil liberties, § Heritage Foundation (2005): Scale 0-100, rounded to nearest 1.0, low is more freedom (reversed from original data), ‡World Bank's government effectiveness indicator (Kaufmann et al. 2005), low is more effective (reversed from original scale). ‡‡ Grim and Finke (2006) and The Association of Religion Data Archives 2005, Scale 0 to 10, increasing with the level of regulation.

Table 3. Quantile Regression Dependent Variable: Log Religion Time*

		Quantile								
	(1) OLS	(2) 30%	(3) 40%	(4) 50%	(5) 60%	(6) 70%	(7) 80%	(8) 90%	(9) 95%	(10) 99%
Log Civil Liberties	-0.498 (0.332)	-1.477* (0.671)	-1.550 (0.847)	-0.994 (0.863)	-0.563 (0.631)	-0.162 (0.396)	-0.044 (0.153)	0.110 (0.154)	0.155 (0.167)	0.138 (0.199)
Log Econ. Freedom	-.824 (0.489)	-0.146 (0.929)	-0.552 (1.215)	-1.933 (1.288)	-1.900 (1.086)	-0.699 (0.803)	-0.343 (0.296)	-0.863* (0.374)	-0.426 (0.368)	-0.210 (0.384)
Log Govt. Effect.	0.538 (0.272)	0.895 (0.428)*	1.053 (0.660)	1.600* (0.747)	1.249 (0.755)	0.253 (0.601)	0.090 (0.129)	0.260 (0.194)	0.139 (0.139)	0.128 (0.183)
Log Earnings	-0.196 (0.050)	-0.171 (0.110)	-0.388** (0.133)	-0.296** (0.114)	-0.237* (0.120)	-0.093 (0.094)	-0.027 (0.032)	-0.050 (0.036)	-0.032 (0.035)	-0.029 (0.031)
Log Religious Reg.	-0.415 (0.207)	-0.497 (0.400)	-0.688 (0.525)	-0.889* (0.404)	-0.677* (0.321)	-0.191 (0.308)	-0.066 (0.069)	-0.269* (0.109)	-0.424** (0.112)	-0.361* (0.140)
Constant	7.312 (1.667)	3.691 (3.529)	7.843 (4.414)	12.304** (4.377)	12.113** (3.724)	7.331** (2.771)	5.676** (1.132)	8.045** (1.202)	6.874** (1.245)	6.662** (1.280)

Civil Liberties, Economic Freedom, and Government Effectiveness on Reverse Scales (higher values = deteriorating institutions); N=25,806; SE in parentheses; *significant at 5%; ** significant at 1%. Log Religion time = log (total hours + 1) to avoid truncation of data where time = 0. Log Religious Regulation = log (Religious regulation score + 1) to avoid truncation where RR score = 0.

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Appendix

Table A. ISSP Survey Countries and relevant data

Country	Civil Liberties[ŧ]	Economic Freedom[§]	Religious Regulation ‡	Government Effectiveness[‡‡]	Mean Earnings[†]
Australia	1	24.16	1.56	1.15	23166.41
Austria	1	30.52	1.0	1.45	14233.68
Bulgaria	3	52.80	7.11	4.03	4235.39
Canada	1	29.97	1.00	0.87	23818.67
Chile	2	23.73	2.39	1.69	4175.28
Cyprus	1	32.58	7.11	1.67	10052.43
Czech Republic	2	31.10	1.00	2.31	2740.543
Denmark	1	33.77	1.83	0.80	28604.17
France	2	36.04	4.89	1.41	21874.49
Germany	2	37.28	3.22	1.22	14289.01
Hungary	2	41.19	8.5	2.24	1742.83
Ireland	1	24.91	1.00	1.27	13597.83
Israel / Palestine	3	36.29	3.22	2.08	15876.42
Italy	2	35.58	3.22	2.01	12352.76
Japan	2	28.85	4.06	1.95	26752.8
Latvia	2	37.59	4.89	2.76	1795.25
New Zealand	1	21.41	1.00	0.99	14740.86
Norway	1	31.82	1.83	0.88	28192.3
Philippines	3	36.17	1.83	2.87	1902.60
Poland	2	38.67	1.00	2.16	3469.68
Portugal	1	34.36	1.00	1.57	5302.43
Russia	4	49.15	5.72	3.62	2065.11
Slovak Republic	2	46.48	2.39	3.00	2160.68
Slovenia	2	41.44	2.39	2.32	6140.623
Spain	2	33.78	2.67	1.05	9597.53
Sweden	1	33.29	1.00	1.01	24076.82
Switzerland	1	21.77	1.00	0.52	37869.25
United Kingdom	2	22.96	1.00	0.61	20065.3
United States	1	23.18	1.00	1.29	15056.25

N=25,806 observations † International Social Survey Programme 1998: Religion II (ISSP 1998), Yearly earnings reported in the data set as median values from survey ranges unique to each country and converted to 1998 dollars. Religious hours per hour are a sum of intermediate values from three different survey questions, ŧ Freedom House (2005): Scale 1-7, low is better civil liberties, § Heritage Foundation (2005): Scale 0-100, rounded to nearest 1.0, low is more freedom (reversed from original data), ‡World Bank's government effectiveness indicator (Kaufmann et al. 2005), low is more effective (reversed from original scale). ‡‡ Grim and Finke (2006) and The Association of Religion Data Archives 2005, Scale 0 to 10, increasing with the level of regulation.