Introduction

In a 2003 paper, Roes and Raymond test Alexander's (1987) hypothesis that group selection creates belief in supernatural beings that are present, active, and concerned with human affairs ("moralizing gods"). Alexander argues that resource-rich environments are the site of inter-group conflict, and that large groups will overwhelm smaller groups in this conflict. He further argues that since internal conflict tends to cause large groups to fission, large groups possessing cultural traits dampening internal conflict would be at a selective advantage. Belief in gods that reinforce group morality is one such force. Using Kendall tau rank correlations, Roes and Raymond attempt to establish whether or not the data in *Ethnographic Atlas* (Murdock 1967) and *Standard Cross-Cultural Sample* (Murdock and White 1969) are consistent with four hypotheses drawn from Alexander:

a) Resource-rich environments are associated with a higher level of inter-societal conflict.

b) Frequency of inter-societal conflict is positively correlated with society size.

c) Resource-rich environments contain larger societies.

d) Belief in moralizing gods is positively correlated with society size.

Roes and Raymond find modest but statistically significant correlations that confirm their four hypotheses. Their finding that moralizing deities are more likely to exist in larger societies has been cited approvingly by a number of authors (e.g., Norenzayan and Shariff 2008:61; Atran and Henrich 2010:2). In this paper, we wish to revisit their study, using more up-to-date methods to examine the forces contributing to a belief in moralizing gods.

There are several problems with the methodology used by Roes and Raymond. Most seriously, they failed to correct for Galton's problem, apparently believing that the sampling method used to select SCCS societies allows them to ignore the issue (Roes and Raymond 2003:128). In fact, as shown in Dow and Eff (2008), relations of borrowing and descent lead to a high degree of dependence among the SCCS societies, and one must therefore employ a methodology that controls for the confounding effect of cultural transmission, such as the spatial econometric methods presented by Dow (2007).

Roes and Raymond ignore the issue of missing data which, as shown by Dow and Eff (2009a, 2009b) can lead to bias in estimated statistics. In addition, some of the variables they select seem rather questionable. For example, their measure of society size (SCCS 237) is actually a measure of political complexity: the number of jurisdictional levels existing above the community described by the SCCS

codings (Roes and Raymond 2003:129); the size of the community (SCCS 63) would be a more direct measure of group size. Similarly, their measure of resource richness (SCCS 859) is actually a measure of subsistence mode (Roes and Raymond 2003:129) rather than a direct measure of the characteristics of the natural environment. Another example of a questionable variable is the inclusion of "reliability" ratings among their measures of internal and external conflict (Roes and Raymond 2003:129-130); reliability ratings report on the reliability of a measure, and are not themselves measures. Finally, several of their variables are collapsed from many into just a few ordinal values, including both the measure of moralizing high gods (from 4 to 2) and the measure of resource richness (from 12 to 3). While making variables more coarse-grained facilitates the use of contingency tables, it also removes valuable variation, which might help the data tell a much richer story in a regression modeling context.

The regression modeling context contains a wide array of tools that can be used to diagnose specification issues and provide remedies. Within such a context, Galton's problem, the problem of missing data, the problems of nonlinearities, confounding variables, endogeneity, and so on, can all be addressed and managed. Below we present a model of the forces that shape the existence of belief in moralizing gods. After briefly reviewing the literature, we discuss our methodology, and describe the variables we draw from the SCCS. Then we present our results, concluding with our interpretations.

The Problem in Depth

Religion, Supernatural Perception and Morality

The topic of religion and morality, that is, the question of whether the presence of religion guides the prosocial character of a society, is found in the literature for sociology, psychology, biology, and anthropology. Saroglou (2006) cites Freud (1919) among others in the belief that religion has a positive effect on morality, Freud writing that religion has a restrictive effect on individuals that inhibits the biological impulses. Despite this, Saroglou leaves room for doubt, stating that most empirical studies on the topic implement self-reporting research. In an earlier paper describing four separate studies (detailed in Saroglou et al., 2005), he concludes that the relationship between religion and prosocial behavior is "a limited but still substantial reality" (2005).

Grottanelli (1969) provides an extremely detailed account of the Nzema people and the relationship between their behavior and religious system. An agricultural ethnic group in West Africa, the Nzema maintain a pantheon of a single high god and many lesser gods characterized as highly moralizing, exacting vengeance upon those individuals who offend them; any form of "dishonesty, uncleanliness, and impurity" merits supernatural punishment. Further, these gods answer

petitions of retribution from wronged individuals (1969). Grottanelli concludes that this characterization of the supernatural enforces the societal concepts of unity, hierarchy, and morality (1969).

Rudmin (1992, 1995) examines correlations between societal characteristics and the institution of private property (using Murdock's *Ethnographic Atlas* in both papers and additionally using Murdock's *Atlas of World Cultures* in 1995). In both, he finds significant evidence for correlation between the presence of private property and cereal grains in agriculture, developed social hierarchies, population size, and "supernatural sanctions for morality".

Cultural Complexity and the Need for the Binding Supernatural

Of interest to Roes and Raymond is the relationship between moralizing gods and complex societies. Complex societies give rise to a characteristic set of cultural problems that can be mitigated by belief in the moralizing supernatural. Humans in organized societies face a cognitive dissonance between the selfish or impulsive tendencies of the individual and the perpetuation of the whole; religion plays an integral role in maintaining social order as it "increase[s] trust among unrelated individuals", which facilitates cooperation on a larger scale (Shariff et al., 2009). Indeed, Shariff et al. and Roes and Raymond state that smaller societies that do not yet possess the hallmarks of cultural complexity (such as hunting, fixity, or agriculture) seem to have supernatural figures that may not be judgmental or concerned with human behavior (in fact, they may not even be omniscient). It can be hypothesized that these smaller, simpler societies are bound and maintained by virtue of their small size and closeness of relation. Moralizing gods are more likely to be found as societies advance and grow, as the social pressures in small communities become less effective at maintaining order in increasingly diverse and expanding populations.

This encourages testing the correlation between society complexity and belief in moralizing gods. The literature indicates that more advanced societies are more likely to have moralizing gods. The converse may very well be true. English anthropologist Edward Tylor (1958) espoused this view: he states that less-developed societies are far more likely to keep the realms of religious and moral beliefs from significant overlap. Stark (2001) contends that this overlap would only occur in complex societies in which gods were specifically morality-enforcing.

Society, Resources, Competition, and Collapse

Alexander (1982) states that organisms are induced to live in groups to facilitate the accruement and utilization of resources and to defend against inter- or intra-species predation and competition. In his (1987) theory of morality, he further states that inter-species competition for resources is a cause of the expansion of

social groups. These complex social groups are prone to fission and are vulnerable to outside influence whether they are driven away from preferable habitats, resources bases, or otherwise "overwhelmed" (Roes and Raymond, 2003). Tainter (1990) states that resource depletion, mismanagement, and competition are among the reasons given for the collapse of complex societies; he also cites social unrest and class conflict as being a possible impetus for collapse and that supernatural enforcers also protect societal hierarchies (1990). It may be hypothesized that moralizing gods will be more likely in societies that are socially complex, resource-rich, and frequently in competition with similar societies.

Methodology

To avoid estimation bias due to Galton's problem and missing data, we follow the methodology developed by Dow (2007), Dow and Eff (2008, 2009a, 2009b), Eff and Dow (2008, 2009), and Eff (2008), basing our R scripts on those given in Eff and Dow (2009).[1] We use multiple imputation to address the problem of missing data, and we use weight matrices for geographical and linguistic proximity to model the influence of cultural transmission via borrowing and inheritance. Since the two weight matrices are highly correlated with each other (physical neighbors often share a recent common ancestor), identification of separate borrowing and ancestry effects is difficult. Employing the composite weight matrix method presented in Dow and Eff (2009a:142), we combine the two weight matrices in order to find the linear combination of the two which best explains the transmission process (i.e., results in higher model R^2); the resulting weights provide a way of assessing the relative importance of the two cultural transmission channels.

Our model takes the form:

$$y = \rho \mathbf{W} y + \mathbf{X}\beta + \varepsilon \quad (1)$$

where y is the dependent variable, $\mathbf{W}y$ is the composite weight matrix times the dependent variable, giving us a measure of cultural transmission, the scalar ρ is the estimated coefficient for cultural transmission, $\mathbf{X}$ is the matrix of our independent variables, β is the vector of estimated coefficients for the independent variables, and ε is a vector of error terms. Since $\mathbf{W}y$ is endogenous, the model must be estimated using two-stage least squares, as described in Dow (2007).

The SCCS contains a relatively small number of cases (186 societies), which makes the issue of missing data especially severe. The most common method for dealing with missing data—listwise deletion—can lead to small sample sizes, in which results can be driven by a few unrepresentative cases, leading to biased

[1] Our scripts are supplied in a zip folder, together with the data sets we use, as supplementary material.

estimates (Dow and Eff 2009b). We create 10 imputed data sets, estimating our model on each data set, and then using rules developed by Donald Rubin (1987) to combine these 10 sets of estimates into a final set of estimates. We use only the 168 observations for which our dependent variable is non-missing, since using imputed values for the dependent variable adds only noise to the model (Dow and Eff 2009b; Von Hippel 2007). In addition, we examine the influence diagnostics (dfbetas and dffits) for our models, in order to assess whether one or more influential case is driving our results (Belsey et al. 1980; Wooldridge 2006:328-332).

Endogeneity is a potential problem with SCCS data. Functional relationships are usually relationships of mutual causation, which implies—in the regression context—that independent variables would correlate with the error term, leading to bias in estimated coefficients. For this reason, we test all of our independent variables for endogeneity, using the Hausman test (Wooldridge 2006:532-533).

Variable Selection

Our dependent variable *moralgods* is the same variable (SCCS 238) used by Roes and Raymond. Each column in Table 1 categorizes SCCS societies by the values they take on for *moralgods*, while each row shows how each society is categorized by specific religion. Increasing values of *moralgods* reflect increasing involvement of deities in human affairs, with the highest value indicating that the gods reinforce human morality. Note that some non-universal religions have gods reinforcing human morality, and some universal religions with well-developed ethical doctrines (notably Buddhism) have relatively low values of *moralgods*, presumably because they lack deities supporting those ethical doctrines. Figure 1 displays the location of the SCCS societies; larger and darker points represent higher values of *moralgods*, while the triangles indicate societies with missing values.

Table 1: Classification by religion

Religion	High gods absent	High gods not active in human affairs	High gods active in human affairs but not supportive of human morality	High gods active and supportive of human morality	Missing values
Indigenous religion	52	36	8	8	12
Deep Islamization	1	0	0	17	1
Deep Christianization	0	0	0	6	0
Superficial Islamization	1	3	0	3	0
Superficial Christianization	9	3	3	6	3
Mahayana Buddhism	4	1	0	0	1
Hinayana Buddhism	0	2	0	0	0
Vajrayana Buddhism	0	0	1	0	1
Hinduism	1	2	1	0	0
Total	68	47	13	40	18

Notes: Columns represent the four categories for our dependent variable *moralgods* (SCCS variable 238). Rows represent nine categories of a variable coded by A. Korotayev, which will be included in the next update of the SCCS (Dow and Eff 2008:168).

Table 2 presents descriptive statistics for all variables we consider in our model, together with their SCCS variable numbers. The variable *commsize* provides a measure of the number of persons within the focal community, while the variable *superjh* reports the number of jurisdictional levels integrating the community into a larger polity—when three or more levels exit above the local community, then the community is considered to be embedded into a state. We take the first principal component of these two variables to create our preferred measure for size: *PCsize*.[2] We also consider population density (*popdens*) as an alternative measure for size.

[2] The correlation between the two variables is 0.506. The first principal component explains 0.635 of the total variation; the Cronbach's alpha is 0.651.

Table 2: Descriptive Statistics

variable	Description	SCCS	n	min	max	mean	sd
moralgods	Degree to which gods reinforce human morality	v238	168	1	4	2.15	1.19
PCAP	1st PC: Agricultural potential high	v921, v928	1680	-3.8	2.7	0	1.28
AP1	Agricultural potential high: sum of scales	v921	168	6	23	16.74	3.43
AP2	Agricultural potential high: minimum of scales	v928	168	0	8	3.75	1.66
PCAP2	PCAP squared	--	1680	0	14.6	1.64	2.77
foodscarc	Chronic resource scarcity high	v1685	132	1	5	2.1	1.27
cultints	Cultivation intensity high	v232	168	1	6	3.43	1.75
irrig	Dummy: irrigation used	(v232==6)*1	168	0	1	0.17	0.37
anim	Percentage subsistence: Animal husbandry	v206	168	0	9	1.57	2.07
milk	Dummy: milk consumed	(v245>1)*1	168	0	1	0.31	0.46
PCsize	1st PC: Community size large	v63, v237	1680	-1.6	3.4	0	1.23
commsize	Community Size	v63	168	1	8	3.51	1.74
superjh	Jurisdictional hierarchy above local community	v237	167	1	5	2.11	1.28
PCsize2	PCsize squared	--	1680	0	11.8	1.5	1.94
popdens	Population Density	v64	166	1	7	3.82	2
classtrat	Degree of class stratification	v270	168	1	5	2.48	1.53
caststrat	Degree of caste stratification	v272	163	1	4	1.27	0.7
exogamy	Marriage outside of community high	v72	167	1	5	3.19	1.2
money	Degree to which money is developed	v155	168	1	5	2.57	1.5
commland	Communal land use rights prevalent	v1726	91	1	3	2.29	0.82
inhreal	Dummy: land is inherited	(v278>1)*1	141	0	1	0.62	0.49
inhmove	Dummy: movable property is inherited	(v279>1)*1	138	0	1	0.86	0.35
marrgood	Dummy: marriage includes transfer of goods	(v208<4)*1	168	0	1	0.6	0.49
theft	Theft high	v1667	105	1	9	4.3	3.12
winconfl	Within-community conflict rare	v767	85	1	4	2.93	0.8
bwnconfl	Between-community conflict rare	v768	84	1	4	2.44	1.12
physforce	Physical force to settle disputes rare	v770	85	1	3	1.92	0.8
intwar	Internal (between-community) warfare rare	v773	80	1	4	2.49	1.3
frqintwar	Internal war infrequent	v891	145	1	3	2.46	0.68
eeintwar	Frequency of internal war high	v1649	139	1	17	7.24	6.55
eeextwar	Frequency of external war high	v1650	142	1	17	7.94	6.62
PCviol	1st PC: Intragroup violence high	v1665, v1666, v666	1680	-2.1	2.4	0	1.35
homicide	Homicide high	v1665	113	1	9	3.93	2.86
assault	Assault high	v1666	105	1	9	4.9	3.09
persviol	Interpersonal violence moderate or frequent	v666	121	1	2	1.67	0.47
PCviol2	PCviol squared	--	1680	0	5.8	1.83	1.74

Notes: Descriptive statistics taken over the 168 observations for which the dependent variable (*moralgods*) is non-missing. Three composite variables are included (*PCAP*, *PCsize*, *PCviol*); for these variables (and their squares), the descriptive statistics describe the 1680 observations in the 10 imputed data sets. SCCS variables are described fully in White et al. (2009).

The SCCS contains several good measures for resource-richness of the local environment. We selected two measures of "agriculture potential", reasoning that land of high potential for agriculture would be exactly the kind of resource-rich

environment that Alexander had in mind, since only this kind of land could support large groups. We combine these two measures by taking their first principal component, giving us our preferred measure of resource-richness: *PCAP*.[3] We also include a measure of chronic resource scarcity (*foodscarc*) as an alternative variable.

Inter-group conflict is measured by a variety of SCCS variables. We select a variable with high variation and a high number of non-missing values: the frequency of external war, coded by Carol and Mel Ember (1992), which we call *eeextwar*.

Intra-group conflict also has multiple codings in the SCCS. Our preferred measure (*PCviol*) is constructed as the first principal component of three variables: the frequency of homicide (*homicide*); the frequency of assault (*assault*); and the frequency of interpersonal violence (*persviol*).[4] We introduce a number of other codings, however, to make it more likely that if there is a relationship between *moralgods* and intra-group conflict, we would find it. These other variables include three measures of intra-group war (*eeintwar*, *intwar*, *frqintwar*) and three variables measuring the degree of conflict and violence within a society (*winconfl*, *bwnconfl*, *physforce*).

Morality maintains group cohesion by suppressing behavior that might lead to within-group conflict. One source of conflict is envy: the hostility felt by low-status persons toward those of higher status. Morality functions to encourage each group member to accept his place, no matter how low that might be. Such morality will be more necessary the more stratified a society. We introduce two variables measuring the degree of stratification: caste stratification (*caststrat*) and class stratification (*classtrat*).

A related problem is that of property rights. Where property can be used to enhance or maintain status, agents will have an incentive to extract property from their neighbors. In such a situation, morality plays a role in defining legitimate paths of property acquisition. Where property is movable and easily alienable, the need to suppress theft is all the more pressing. Thus we would predict that pastoral societies would be more likely to have moralizing gods; the variable we use is the importance of animal husbandry in subsistence (*anim*). As alternative variables we consider: whether milk is consumed (*milk*); the degree to which money is developed (*money*); whether communal land rights are prevalent

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[3] The correlation between the two variables is 0.637. The first principal component explains 0.680 of the total variation; the Cronbach's alpha is 0.667.

[4] The correlation between homicide and assault is 0.636; the correlation between homicide and persviol is 0.224; and the correlation between assault and persviol is 0.346. The first principal component explains 0.479 of the total variation; the Cronbach's alpha is 0.626.

(*commland*); whether land is inherited (*inhreal*); whether movable property is inherited (*inhmove*); whether marriage involves an inter-family transfer of goods (*marrgood*); and whether theft is widespread (*theft*).

Some technologies, such as irrigation, require a high degree of coordination among the members of a society. Divinely sanctioned morality may be especially useful in maintaining that coordination. We create a dummy variable for the presence of irrigation (*irrig*), and we also use a more general variable for the intensity of cultivation (*cultints*).

Finally, societies would have greater need for moralizing gods when agents live in communities containing non-kin, who are not motivated by nepotism and are more likely to behave opportunistically. We attempt to measure the weakness of nepotism by using a measure of the degree of exogamy (*exogamy*), since consanguineal ties would presumably be strongest in endogamous communities.

Figure 2 displays the variables we have chosen to represent the four key concepts in the Roes and Raymond study: *PCAP*, *eeextwar*, *PCsize*, and *moralgods*. Of their four explicitly stated hypotheses, three are consistent with these data: there exist significant positive relationships between society size and external war, between resource richness and society size, and between society size and moralizing gods. There is, however, no significant relationship between resource richness and external war. Neither is there a significant relationship between resource richness and moralizing gods, nor between external war and moralizing gods—both relationships implicit in the theory the authors draw from Alexander.

Estimation and Results

We create 10 imputed data sets with the R package *mice* (Van Buuren and Oudshoorn 2009), using the auxiliary data described in Eff and Dow (2009) as well as all of the data used in our unrestricted model. Our next step is to find the optimal composite weight matrix. We find $\mathbf{W}$ by estimating 21 models, containing all of our candidate independent variables, as well as a single cultural transmission term $\mathbf{W}y$, in which $\mathbf{W}$ is a linear combination of the distance and language proximity matrices: $\mathbf{W} = p\mathbf{W}_D+(1-p)\mathbf{W}_L$. Each of the 21 models differs in the parameter p, which takes on the values (0,.05,.10,.15,… .95,1.0). The optimal weight matrix is that which leads to the highest model R^2: it has a weight on distance of 1, and a weight on language of 0, suggesting that diffusion by cultural borrowing accounts for the presence of moralizing gods, and that cultural inheritance is not an important transmission channel.

Using this optimal weight matrix, we first estimate an unrestricted model, containing all of our candidate independent variables. Table 3 shows the estimated coefficients, with pvalues, variance inflation factors, and the standardized coefficients. With this model as our starting point, we drop

insignificant variables, using a Wald test to judge the appropriateness of our restricted model. At the same time, we test if interaction terms, squared terms, or variables that we had already dropped could be added to the model, using the R function *add1*.

Table 3: Unrestricted Model

variable	Description	coef	pvalue	VIF	stdcoef	
(Intercept)		0.550	0.541			
Wy	Cultural transmission	0.772	0	2.45	0.417	***
PCAP	1st PC: Agricultural potential high	-0.130	0.081	1.853	-0.140	*
PCAP2	PCAP squared	-0.001	0.971	1.85	-0.003	
foodscarc	Chronic resource scarcity high	0.107	0.133	1.361	0.115	
cultints	Cultivation intensity high	-0.062	0.480	4.641	-0.091	
irrig	Dummy: irrigation used	0.084	0.775	2.482	0.026	
anim	Percentage subsistence: Animal husbandry	0.035	0.545	2.667	0.061	
milk	Dummy: milk consumed	0.512	0.097	3.849	0.199	*
PCsize	1st PC: Community size large	0.327	0.008	4.823	0.337	***
PCsize2	PCsize squared	-0.130	0.007	1.883	-0.212	***
popdens	Population Density	-0.051	0.420	3.396	-0.086	
classtrat	Degree of class stratification	0.020	0.768	2.206	0.025	
caststrat	Degree of caste stratification	0.154	0.230	1.508	0.091	
exogamy	Marriage outside of community high	0.013	0.860	1.401	0.013	
money	Degree to which money is developed	0.053	0.466	2.154	0.067	
commland	Communal land use rights prevalent	0.023	0.877	1.832	0.017	
inhreal	Dummy: land is inherited	-0.003	0.989	2.589	-0.001	
inhmove	Dummy: movable property is inherited	-0.368	0.146	1.564	-0.117	
marrgood	Dummy: marriage includes transfer of goods	0.172	0.294	1.338	0.071	
theft	Theft high	0.037	0.303	1.766	0.099	
winconfl	Within-community conflict rare	0.118	0.362	1.628	0.082	
bwnconfl	Between-community conflict rare	0	0.998	3.127	-0.002	
physforce	Physical force to settle disputes rare	-0.028	0.841	1.830	-0.018	
intwar	Internal (between-community) warfare rare	0.079	0.439	2.470	0.085	
frqintwar	Internal war infrequent	-0.249	0.073	1.611	-0.144	*
eeintwar	Frequency of internal war high	0.003	0.867	2.809	0.018	
eeextwar	Frequency of external war high	-0.039	0.022	2.110	-0.217	**
PCviol	1st PC: Intragroup violence high	-0.098	0.209	2.049	-0.112	
PCviol2	PCviol squared	0.044	0.381	1.261	0.065	

Notes: $R^2 = 0.564$; N=168; number of imputations=10; standard errors and R^2 adjusted for two-stage least squares. "***" p-value ≤0.01, "**" p-value ≤0.05, "*" p-value ≤0.10. Composite matrix weights: distance=1.0, language=0.

After several iterations, we end up with the final restricted model, presented in Table 4. All coefficients are significant, and the results of the diagnostics are all satisfactory. The Wald test (Wooldridge 2006:587) shows that it is reasonable to retain only the selected variables in this final model; the Hausman tests (Wooldridge 2006:532-533) show that none of the variables are endogenous; the Shapiro-Wilk test (Shapiro and Wilk 1965) shows there are no problems of non-normal residuals; the Breusch-Pagan test (Wooldridge 2006:280) shows that the residuals are homoskedastic; Ramsey's RESET test shows that the model cannot

be improved by additional nonlinearities (Wooldridge 2006:308); and the LM test for spatial lag shows that the model cannot be improved by including a cultural transmission term based on the linguistic weight matrix (Anselin 1988; Bivand et al. 2009).[5]

Table 4: Restricted Model

Variable	Description	coef	pvalue	VIF	stdcoef	R^{2p}	
(Intercept)		0.003	0.993				
Wy	Cultural transmission	0.933	0	1.545	0.504	0.235	***
PCAP	1st PC: Agricultural potential high	-0.129	0.026	1.184	-0.139	0.012	**
foodscarc	Chronic resource scarcity high	0.115	0.046	1.028	0.123	0.016	**
anim	Percentage subsistence: Animal husbandry	0.083	0.047	1.548	0.143	0.113	**
PCsize	1st PC: Community size large	0.226	0.002	1.773	0.233	0.038	***
PCsize2	PCsize squared	-0.114	0.006	1.376	-0.186	0.011	***
caststrat	Degree of caste stratification	0.209	0.043	1.139	0.124	0.034	**
eeextwar	Frequency of external war high	-0.039	0	1.102	-0.216	0.025	***

Diagnostics	Fstat	df	pvalue
RESET test. H0: model has correct functional form	0.927	382	0.336
Wald test. H0: appropriate variables dropped	0.714	55	0.402
Breusch-Pagan test. H0: residuals homoskedastic	0.212	7878	0.646
Shapiro-Wilk test. H0: residuals normal	0.809	108	0.370
LM test. H0: Spatial lag (language) not needed	1.083	3E+06	0.298
Hausman test. H0: anim exogenous	0.048	4323	0.827
Hausman test. H0: Wy exogenous	0.496	5697	0.481
Hausman test. H0: PCAP exogenous	0.467	196013	0.494
Hausman test. H0: foodscarc exogenous	0.163	3091	0.686
Hausman test. H0: eeextwar exogenous	0.673	3672	0.412
Hausman test. H0: caststrat exogenous	0.063	1591	0.803
Hausman test. H0: PCsize exogenous	0.821	6635	0.365
Hausman test. H0: PCsize2 exogenous	0.873	12002	0.350

Notes: R^2 = 0.485; N=168; number of imputations=10; standard errors and R^2 adjusted for two-stage least squares. "***" p-value ≤0.01, "**" p-value ≤0.05, "*" p-value ≤0.10. Composite matrix weights: distance=1.0, language=0. R^{2p} is the R^2 partitioned to each independent variable (Chevan and Sutherland 1991; Grömping 2006).

Table 4 shows two ways of assessing the relative importance of each independent variable: standardized coefficients, which give the number of standard deviations the dependent variable changes for a one standard deviation increase in the independent variable; and relative importance (R^{2p}), which shows the variable contribution to R^2, averaging over all possible orders of entering the variable to the model (Chevan and Sutherland 1991; Grömping 2006).

[5] The dfbetas and dffits influence diagnostics (Belsey et al. 1980; Wooldridge 2006:328-332), which we do not report, show that the four societies that overall have the most influence on our results (though in contradictory ways) are the Negri Sembilan, the Copper Eskimo, the Warrau, and the Toda. Nevertheless, no single society drives our results.

Like Roes and Raymond, we find no significant relationship between moralizing gods and intra-group conflict. Nevertheless, there are several key ways in which this model differs from their results. First, the extra-group conflict coefficient has a negative sign, indicating that moralizing gods are *less* likely to be found where external war is prevalent.[6] Second, the coefficient for resource richness is negative, indicating that moralizing gods are *less* likely to be found in rich environments. Third, the coefficient for our alternative measure of resource richness (*foodscarc*) also indicates that moralizing gods are less likely in rich environments. Fourth, the relationship between group size and moralizing gods is nonlinear—the likelihood of moralizing gods initially increases as group size increases, and then begins to decrease.

Additionally, we consider several factors not considered by Roes and Raymond. The first of these, cultural transmission (*Wy*), turns out to be overwhelmingly the most important force conditioning the presence of moralizing gods, and that transmission is geographic, based on diffusion across space, rather than linguistic, based on transmission from a common ancestor. Second, animal husbandry (*anim*) is the second most influential independent variable, and the only property-related variable to enter into the final model, suggesting that protection of easily alienable property is often a major function of morality. Third, we consider the possibility that caste and class privileges are reinforced by moralizing gods;[7] our model finds that caste- (but not class-) stratification is a significant determinant of the degree to which gods reinforce human morality. Fourth, we test whether irrigation, a technology requiring a great deal of coordination among a society's members, is a major determinant of moralizing gods, and find that it is not significant, nor is more general intensity of cultivation. Finally, we examine whether moralizing gods are more likely to exist in societies where communities contain fewer consanguineal kin, and find no evidence that they are.

Discussion

The implications of our results differ significantly from those drawn from Alexander by Roes and Raymond. In our set of 168 SCCS societies, cultural transmission, through the channel of diffusion from neighboring societies, explains nearly a quarter of the variation in existence of moralizing gods. Our other independent variables, positing that moralizing gods exist as a *functional* response to societal conditions, jointly account for another quarter of the variation. The perspective presented by Roes and Raymond posits a specific

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[6] Following the suggestion of a reviewer, we experimented by replacing *eeextwar* with another SCCS variable for external war: *v892* (higher values indicate *less* external war). The coefficient for this was positive (consistent with our results), though insignificant.

[7] Roes and Raymond (2003:132) use these as control variables.

functional purpose for moralizing gods: that they help large groups hold together when in a struggle with other groups for control of rich resources. We find, however, that the existence of external war makes moralizing gods less likely, and we find moralizing gods less likely in areas with rich resources. Further, we find that larger groups are more likely to have moralizing gods only up to a point, and then increasing group size is accompanied by decreasing likelihood of moralizing gods, as shown in the right panel of Figure 3. Our results are not consistent with the perspective presented by Roes and Raymond.

The societal conditions for which moralizing gods provide a functional response can find a functional response from other sources. Large-group integration can be accomplished through bureaucratic institutions such as police, or through institutions facilitating decentralized cooperation, such as money and markets. Moralizing gods compete, in a sense, with these other means of integrating groups.

We suggest that the state is an especially efficient method for holding together large groups. Some support for this can be seen in Figure 3, in the panel at the right showing the nonlinear relationship between societal size and the existence of moralizing gods. The diameter of each point in the plot is proportional to the number of societies of that particular size—one can see from the size of the points that most SCCS societies are found on the ascending portion of the curve. The color of each point is proportional to the percent of the societies of that size that are states: darker points contain a higher proportion of states. There are 30 states in our sample of 168 SCCS societies (identified on the map), and all lie near the top of the curve, or on the descending portion. We interpret this curve as showing that smaller states are more likely to have moralizing gods, but that moralizing gods are less prevalent, because less necessary, in the larger states, which have other means of encouraging group cohesion.

Not only can other institutions such as the state substitute for the function of moralizing gods, but moralizing gods can act as a functional response for a number of different conditions. We think that bolstering property rights is a particularly important function, especially in pastoral societies. Property in pastoral societies consists of domestic animals, which are easy to move and therefore easy to steal. No pastoral society could long endure without institutions discouraging theft. Since pastoral societies typically have low population densities, and are organized on a kin basis, not as states, moralizing gods would constitute one of the few viable theft-discouraging institutions. Our empirical results support this view: the independent variable *anim* (dependence on animal husbandry) was the second most influential independent variable, explaining over 11 percent of variation in the dependent variable. The scatter plot at bottom right in Figure 3 shows the relationship between group size and dependence on animal

husbandry; societies organized as states are presented as brown squares—only one state appears among the societies most dependent on animal husbandry. Other variables measuring some dimension of property fail to enter the final model, suggesting that the function of moralizing gods as stabilizer of property rights may be only important for non-state societies with easily alienable and especially valuable property.

We speculate, as do Roes and Raymond (2003:132), that one function of moralizing gods might be to legitimize and maintain social hierarchies. We find that caste stratification is indeed associated with moralizing gods, though not class stratification. The scatter plots at the bottom left of Figure 3 show the relationships between these two kinds of stratification and group size. Compared to caste stratification, class stratification is more likely to be at high levels in states. This suggests that moralizing gods help provide legitimacy for social hierarchies, but that they perform this role primarily in non-state societies.

Large non-state societies, medium-sized by contemporary standards, would be representative of the large groups in Alexander's theory about the *origin* of moralizing gods. Thus, our findings do not contradict his theory, but merely add something to it: that other institutions—most notably those associated with the state—provide alternative mechanisms for creating large-group cohesion, and that these mechanisms make a belief in moralizing gods redundant in the largest contemporary groups.

Summary and Conclusion

While most societies have a belief in supernatural entities, most do not have a belief in gods who actively support human morality. Roes and Raymond (2003) use pair-wise rank-order correlations on cross-cultural data to examine Richard Alexander's (1987) explanation for the existence of moralizing gods: that supernatural support for human morality made large groups more cohesive and therefore more successful in struggles for resource-rich environments. They find that their results are consistent with Alexander's reasoning.

We revisit Roes and Raymond's work within a regression modeling context, using the methods presented in a series of papers by Dow and Eff. We employ multiple imputation to handle the problem of missing data; use a cultural transmission term to address Galton's problem; and use a full suite of econometric modeling techniques to manage issues related to model specification.

Our results differ from those of Roes and Raymond: we find that moralizing gods are *less* likely to exist in resource-rich environments and in societies chronically engaged in external war. Even more significantly, we find that the relationship between moralizing gods and society size is quadratic, such that large states are less likely than small states to have moralizing gods. We think this indicates that

large states have other ways of reinforcing morality and creating group cohesion, making moralizing gods redundant.

We find that moralizing gods are more likely to exist in pastoral societies. We interpret this as a sign that property constitutes a key moral problem, which is likely to be particularly acute in pastoral societies. These have valuable and easily movable property, making theft likely, but are seldom organized as states, and therefore lack institutions such as police that would help to stabilize property rights. Moralizing gods thus serve to reinforce the legitimacy of property rights.

The most powerful determinant for the existence of moralizing gods is, however, cultural transmission, in the form of diffusion from neighboring societies. Without accounting for cultural transmission, estimates of other effects would have been biased. This result highlights the importance of addressing Galton's problem, whenever working with cross-cultural data sets, including the Standard Cross-Cultural Sample.

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References

Alexander, R.D. 1987. *The Biology of Moral Systems*. 2nd ed. Piscataway, NJ: Aldine Transaction.

— — — . 1982. *Darwinism and Human Affairs*. Seattle: University of Washington Press.

Anselin, Luc. 1988. Lagrange Multiplier test diagnostics for spatial dependence and spatial heterogeneity. *Geographical Analysis* 20:1-17.

Atran, Scott, and Joseph Henrich. 2010. The Evolution of Religion: How Cognitive By-Products, Adaptive Learning Heuristics, Ritual Displays, and Group Competition Generate Deep Commitments to Prosocial Religions. *Biological Theory*. 5(1):1-13.

Belsey, D.A., E. Kuh, and R.E. Welsch. 1980. *Regression Diagnostics: Identifying Influential Data and Sources of Collinearity*. New York: John Wiley and Sons.

Bivand, R., with contributions by L. Anselin, R. Assunçaõ, O. Berke, A. Bernat, M. Carvalho, Y. Chun, C. Dormann, S. Dray, R. Halbersma, E. Krainski, N. Lewin-Koh, H. Li, J. Ma, G. Millo, W. Mueller, H. Ono, P. Peres-Neto, M. Reder, M. Tiefelsdorf and D. Yu. (2009). *spdep*: Spatial dependence: weighting schemes, statistics and models. R package version 0.4-34.

Chevan, A., and M. Sutherland. 1991. Hierarchical partitioning. *The American Statistician* 45: 90- 96.

Cleveland, W.S. 1979. Robust locally weighted regression and smoothing scatterplots. *Journal of the American Statistical Association* 74:829–836.

Dow, M.M. 2007. Galton's Problem as multiple network autocorrelation effects. *Cross-Cultural Research* 41: 336-363.

Dow, M.M., and E.A. Eff. 2008. Global, Regional, and Local Network Autocorrelation in the Standard Cross-Cultural Sample. *Cross-Cultural Research* 42(2):148-171.

— — — . 2009a. Cultural trait transmission and missing data as sources of bias in cross-cultural research: Explanations of polygyny re-examined. *Cross-Cultural Research* 43: 134-151.

— — — . 2009b. Multiple imputation of missing data in cross-cultural samples. *Cross-Cultural Research* 43: 206-229.

Eff, E.A. 2008. Weight Matrices for Cultural Proximity: Deriving Weights from a Language Phylogeny. *Structure and Dynamics: eJournal of Anthropological and Related Sciences*. Vol. 3, No. 2, Article 9. http://repositories.cdlib.org/imbs/socdyn/sdeas/vol3/iss2/art9

Eff, E.A., and M.M. Dow. 2008. Do Markets Promote Prosocial Behavior? Evidence from the Standard Cross-Cultural Sample. MTSU Department of Economics and Finance Working Paper: http://econpapers.repec.org/paper/mtswpaper/200803.htm

— — — . 2009. How to Deal with Missing Data and Galton's Problem in Cross-Cultural Survey Research: A Primer for R. *Structure and Dynamics: eJournal of Anthropological and Related Sciences*. Vol. 3, No. 3, Article 1. http://escholarship.org/uc/item/7cm1f10b

Ember, C. R., and M. Ember. 1992. Warfare, aggression, and resource problems: Cross-cultural codes. *Cross-Cultural Research.* 26(1):169-186.

Freud, S. *Totem and Taboo*. 1919. London: Routledge.

Grömping, U. 2006. Relative Importance for Linear Regression in R: The Package *relaimpo*. *Journal of Statistical Software*, 17(1), 1--27.

Grottanelli, V.L. 1969. Gods and Morality in Nzema Polytheism. *Ethnology* 8.4: 370-405.

Murdock, G.P. and White, D.R. 1969. Standard Cross-Cultural Sample. Ethnology 8(4):329-369.

Norenzayan, A., and A. F. Shariff. 2008. The origin and evolution of religious prosociality. *Science* 322, no. 5898: 58.

Roes, F.L., and M. Raymond. Belief in moralizing gods. *Evolution and Human Behavior* 24.2 (2003): 126-35.

Rubin, D.B. 1987. *Multiple Imputation for No response in Surveys*. New York: Wiley.

Rudmin, F.W. 1992. Cross-Cultural Correlates of the Ownership of Private Property: A Look from Another Data Base. *Anthropologica* 34: 71-88.

— — —. Cross-cultural Correlates of the Ownership of Private Property: Two Samples of Murdock's Data. *The Journal of Socio-Economics* 24.2, 345-373.

Saroglou, V.. 2006. Religion's Role in Prosocial Behavior: Myth or Reality? *Psychology of Religion Newsletter* 31.2: 1-16.

Saroglou, V., I. Pichon, L. Trompette, M. Verschueren, and R. Dernelle. 2005. Prosocial Behavior and Religion: New Evidence Based on Projective Measures and Peer Ratings. *Journal for the Scientific Study of Religion* 44.3.

Shapiro, S.S. and M.B. Wilk. 1965. An analysis of variance test for normality (complete samples). *Biometrika* 52.3-4: 591–611.

Shariff, A., Norenzayan, A., & Henrich, J. The birth of high gods. In M. Schaller, A. Norenzayan, S. Heine, T. Kameda, & T. Yamagishi, (Eds.). *Evolution, Culture, and the Human Mind.* New York: Lawrence Erlbaum Associates.

Stark, R. 2001. Gods, Rituals, and the Moral Order. *Journal for the Scientific Study of Religion* 40.4: 619-36.

Tainter, J.A. 1990. *The Collapse of Complex Societies*. Cambridge: Cambridge University Press.

Tylor, E.B. 1958. *Religion in Primitive Culture*. New York City: Harper and Brothers.

Van Buuren, S. and C.G.M. Oudshoorn. 2009. *mice*: Multivariate imputation by chained equations. R Package 1.21. //web.inter.nl.net/users/S.van.Buuren/mi/hmtl/mice.htm

Von Hippel, P.T. 2007. Regression with missing Ys: An improved strategy for analyzing multiply imputed data. *Sociological Methodology* 2007: 83-117.

White, D.R. 2007. Standard Cross-Cultural Sample. International Encyclopedia of the Social Sciences. (2nd edition). Vol "S":88-95. New York: Macmillan Reference USA. http://intersci.ss.uci.edu/wiki/pub/IntlEncyStdCross-CulturalSample.pdf

White, D.R., M. Burton, W. Divale, P Gray, A. Korotayev, D. Khalturina. 2009. Standard Cross-Cultural Codes. UC Irvine. http://eclectic.ss.uci.edu/~drwhite/courses/SCCCodes.htm

Wooldridge, J.M. 2006. *Introductory Econometrics: A Modern Approach.* Thomson South-Western.

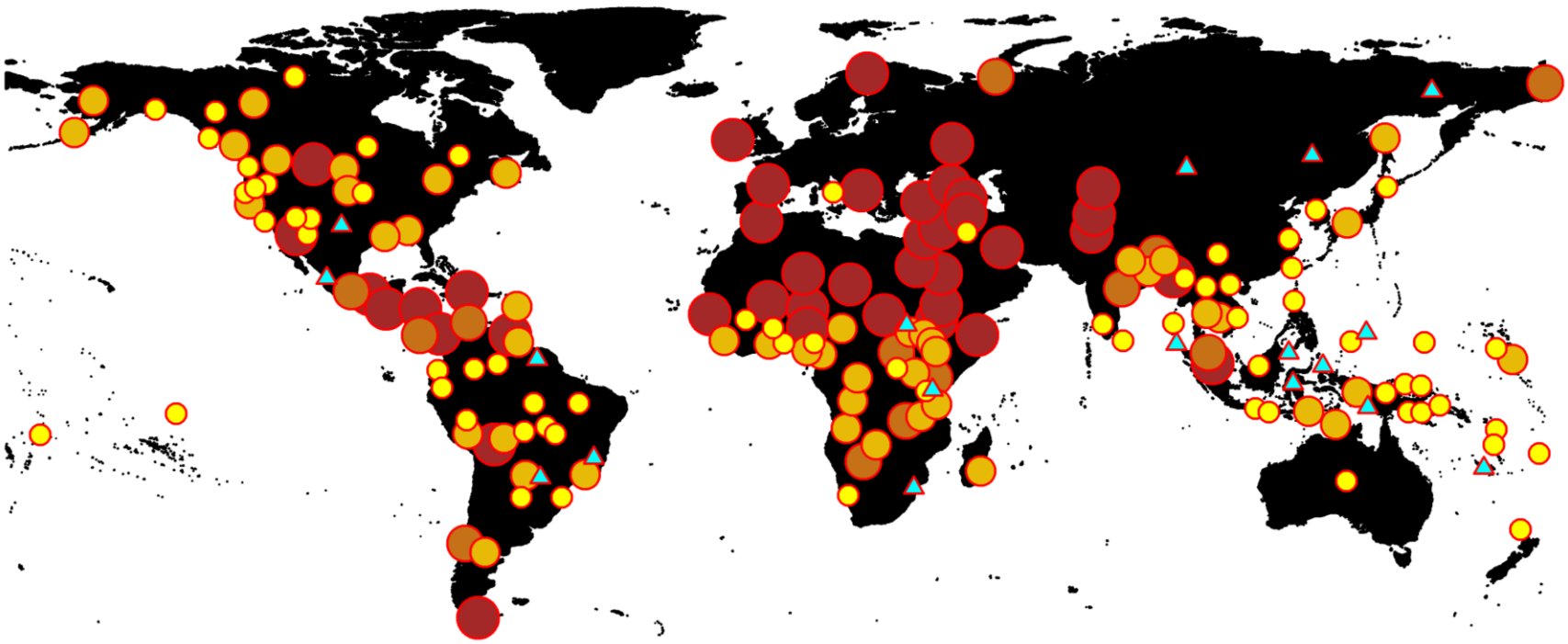

Figure 1: Each point represents an SCCS society. The triangles are the 18 societies with missing data for SCCS variable 238, not used in the regression analysis. The larger and darker the circle, the greater the degree to which gods reinforce human morality.

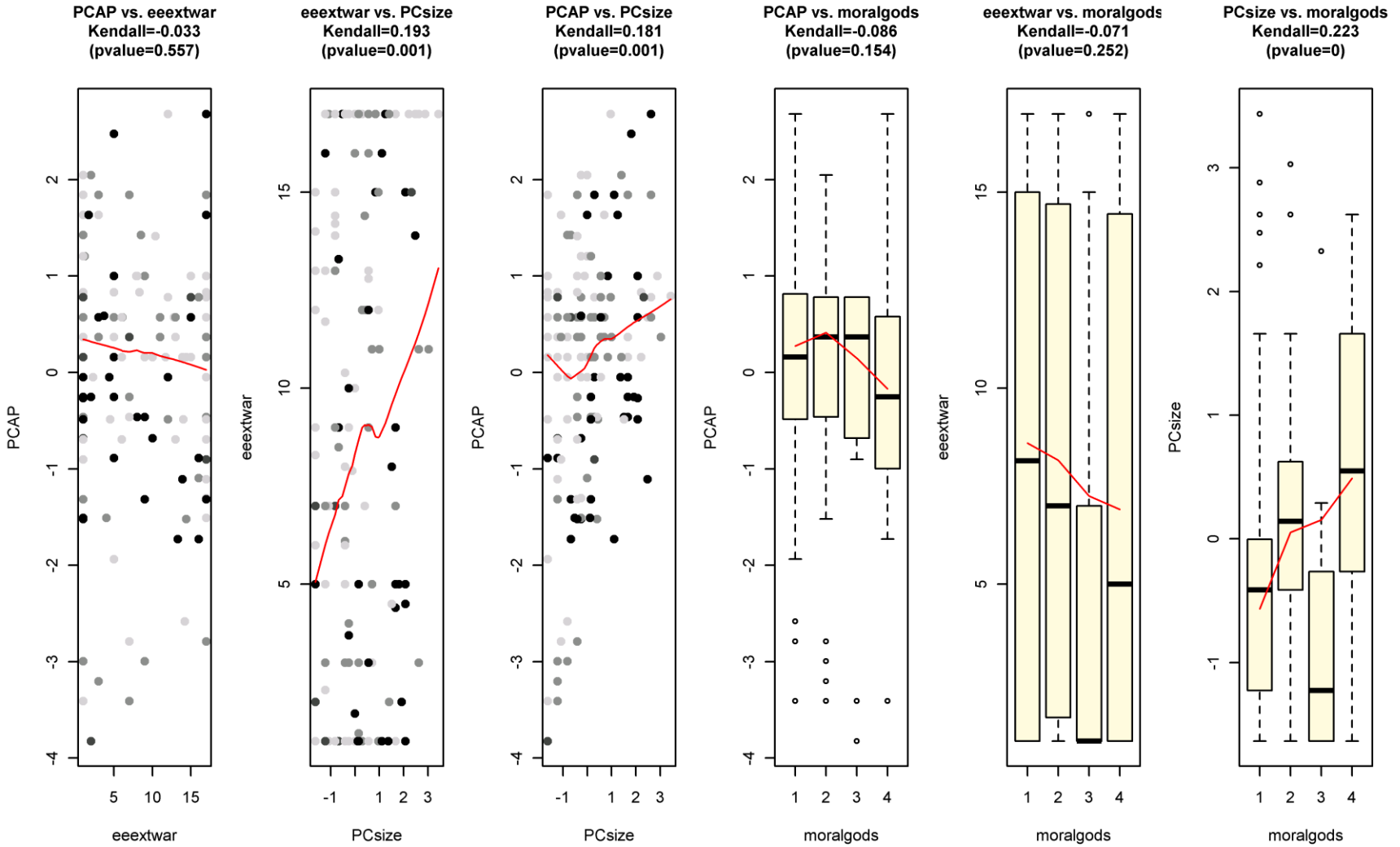

Figure 2: The plots display the relationships examined by Roes and Raymond. The points in the scatter plots at the left vary in color: darker points represent higher values of *moralgods* The box plots at right show how values of the three other variables vary across values of *moralgods*. The red line is the lowess smoother (Cleveland 1979). The Kendall tau is given above each plot.

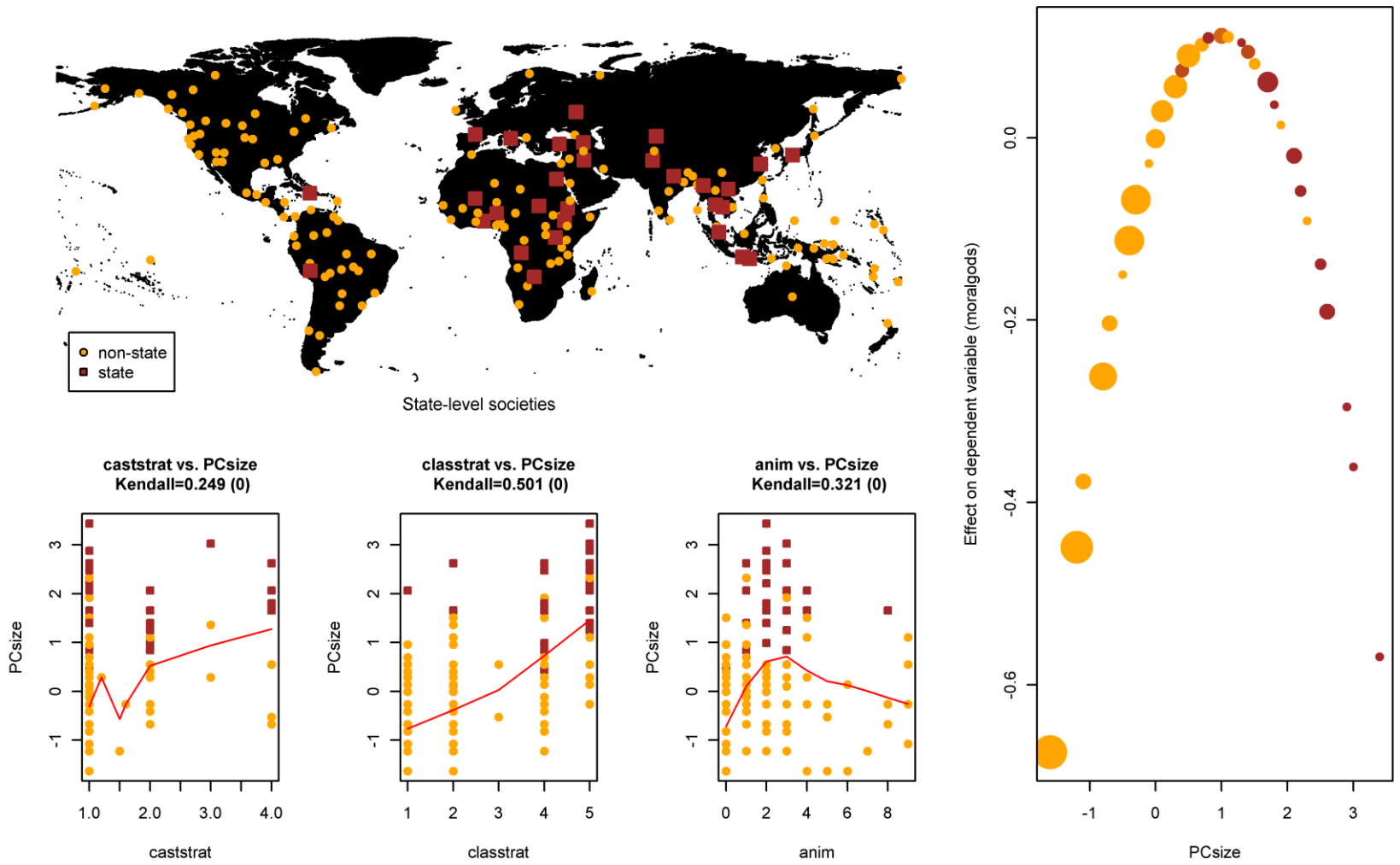

Figure 3: The plot on the right shows the nonlinear estimated relationship between *PCsize* and *moralgods*; the size of each circle represents the number of societies with that value of *PCsize*; the darker the shade, the higher the proportion of societies that are states. The SCCS societies that are states are displayed on the map. The scatter plots at the bottom show the relationship between *PCsize* and three other variables. States are indicated in the scatter plot with the same symbols used on the map. The red line is the lowess smoother (Cleveland 1979)