

# Modeling the Decline of Religion

Richard Wiener

Research Corporation for Science Advancement  
& University of Arizona, Physics

Haley Yaple & Daniel Abrams\*

Northwestern University, Applied Math

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**\*B14.00009 : Competition in social systems: three and a half models**  
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# Competition for membership between two social groups $X$ and $Y$

Research in social conformity suggests

- A group with more members is typically more attractive to potential new members.
- A group with a higher perceived social status or utility is more likely to draw in new members.



# The Model

$$\frac{dx}{dt} = yP_{yx}(x, u_x) - xP_{xy}(x, u_x)$$

$P_{yx}$  probability, per unit of time, of a member converting from  $Y$  to  $X$

$x$  fraction of the population belonging to  $X$  at time  $t$

$0 \leq u_x \leq 1$  measure of perceived utility or status of  $X$

$y$  is complementary fraction to  $x$  and  $x_0$  is initial fraction

$$P_{xy}(x, u_x) = P_{yx}(1-x, 1-u_x)$$

$$P_{yx}(x, 0) = P_{yx}(0, u_x) = 0$$



# Model Provides a General Theoretical Framework

For example, appropriate choice of  $P_{yx}$  leads to

- Ising model
- Kuramoto model

We choose\*

$$P_{yx}(x, u_x) = cx^a u_x$$

\* Abrams, D. M. and Strogatz, S.H. *Modelling the dynamics of language death*. Nature 424(6951), 900 (2003).



# Flow in $x$ for values of $a$

$a \geq 1$  competitive exclusion;  $a < 1$  stable coexistence

$a > 1$



$a = 1$



$a < 1$



# Application of model to religious affiliation

$X$  represents people claiming no religious affiliation

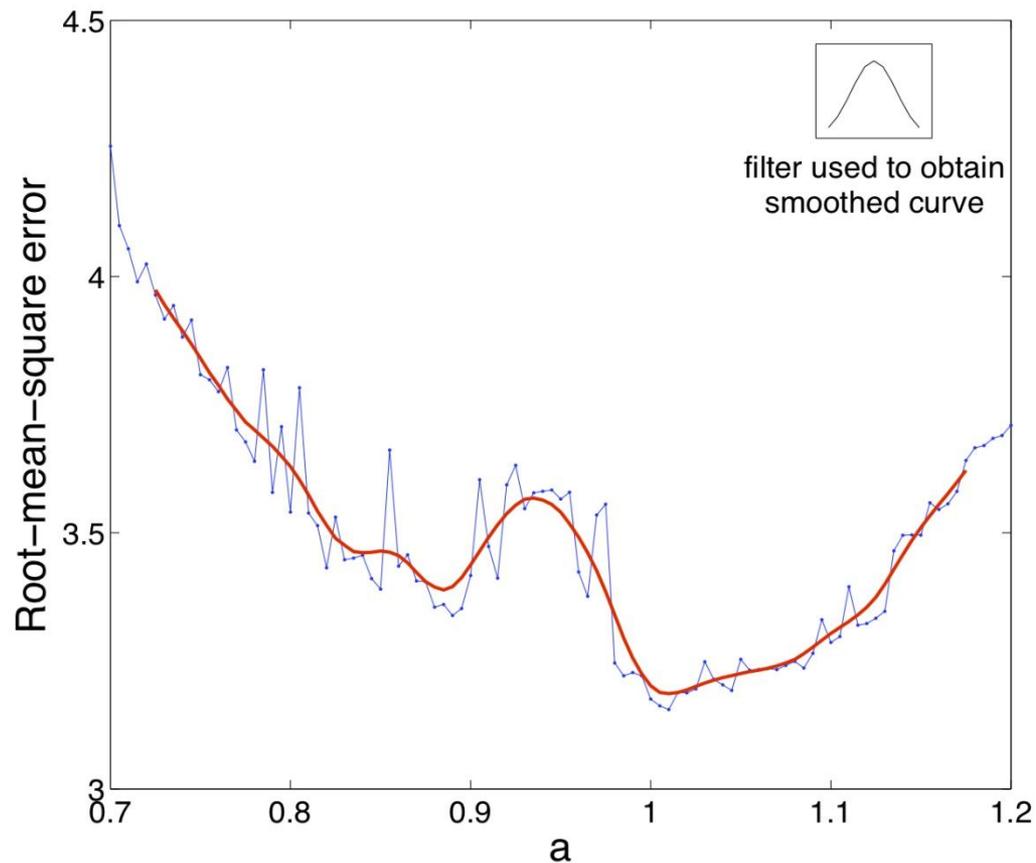
$Y$  represents people claiming membership in a religion—treating all religions as one group is plausible where religion is homogeneous

We compare the model to historical census data from 85 data sets with five or more independent data points from nine modern secular democracies: Australia, Austria, Canada, the Czech Republic, Finland, Ireland, the Netherlands, New Zealand, and Switzerland

We fit the model to all 85 data sets with  $x_0$  and  $u_x$  varied to optimize the fit to each data set and  $a$  and  $c$  taken to be global



# Summed root-mean-square error over all data



Model with  $a = 1$  reduces to logistic growth

$$\frac{dx}{dt} = cx(1-x)(2u_x - 1)$$

Two fixed points at  $x^* = 0$  and  $x^* = 1$ ; competitive exclusion

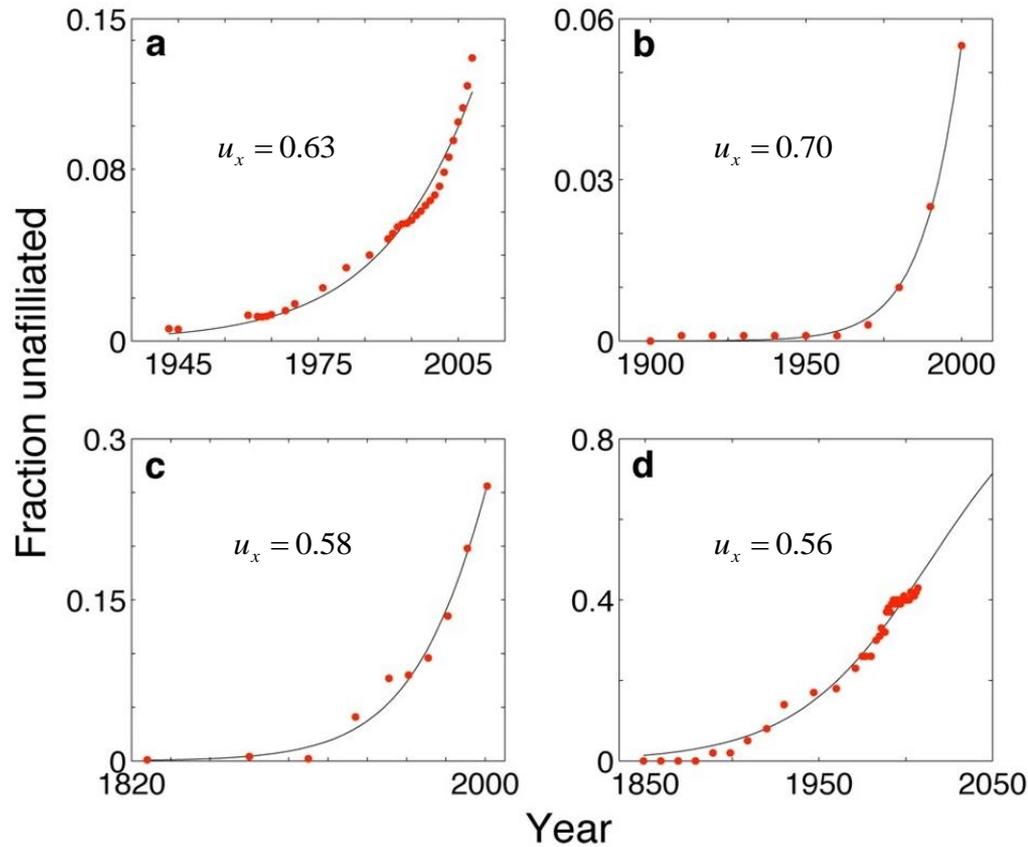
If  $u_x > 0.5$  then  $x^* = 1$  is stable and  $x^* = 0$  is unstable, for any value of  $x_0$

Population becomes 100% unaffiliated; religion is driven to extinction

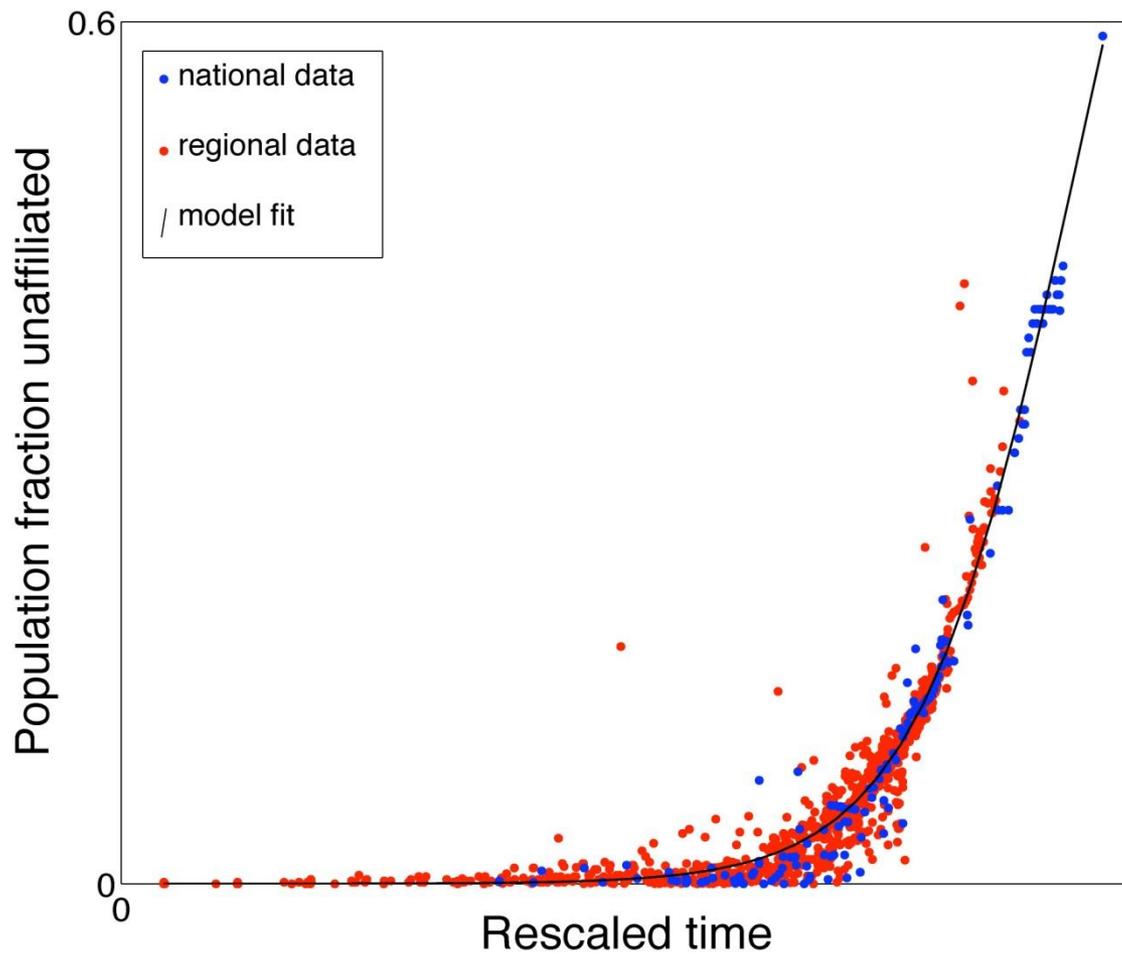


# Example Data Sets

- a) Aland islands, Finland b) Schwyz Canton, Switzerland  
c) Vienna Province, Austria d) the Netherlands



# Model fit to all data

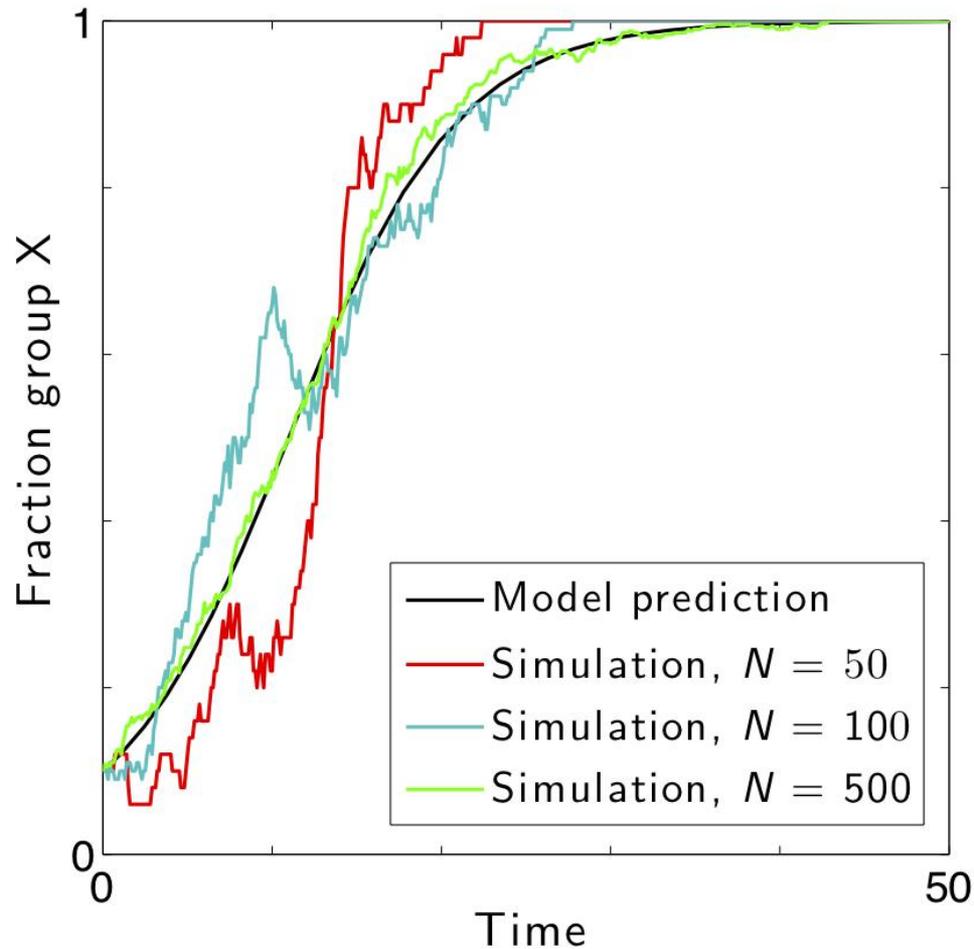


$$u_x = 0.65$$



# Numerical simulation of all-to-all network

Prelude to investigating more complex network structure



# Conclusions

- We have developed a general framework for modeling competition between two social groups
- Particular case fits historical census data on competition between religious and irreligious groups in many modern secular societies
- This simple model predicts that in societies where the perceived utility of non-affiliation is greater than of affiliation, religions will continue to lose members and gradually die out

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