

How Bayesian Analysis Cracked the Red-State, Blue-State Problem

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Abstract. In the United States as in other countries, political and economic divisions cut along geographic and demographic lines. Richer *people* are more likely to vote for Republican candidates while poorer voters lean Democratic; this is consistent with the positions of the two parties on economic issues. At the same time, richer *states* on the coasts are bastions of the Democrats, while most of the generally lower-income areas in the middle of the country strongly support Republicans. During a research project lasting several years, we reconciled these patterns by fitting a series of multilevel models to perform inference on geographic and demographic subsets of the population. We were using national survey data with relatively small samples in some states, ethnic groups and income categories; this motivated the use of Bayesian inference to partially pool between fitted models and local data. Previous, non-Bayesian analyses of income and voting had failed to connect individual and state-level patterns. Now that our analysis has been done, we believe it could be replicated using non-Bayesian methods, but Bayesian inference helped us crack the problem by directly handling the uncertainty that is inherent in working with sparse data.

Key words and phrases: Multilevel regression and poststratification (MRP), political science, sample surveys, sparse data, voting.

1. INTRODUCTION

Income and economic redistribution are central to electoral politics. In the United States as in other countries, political and economic divisions cut along geographic and demographic lines. Richer *people* are more likely to vote for Republican candidates while poorer voters lean Democratic; this is consistent with the positions of the two parties on economic issues. At the same time, richer *states* on the coasts are bastions of the Democrats, while most of the generally lower-income areas in the middle of the country strongly support Republicans. This geographic pattern is consistent with the sense of a culture war between richer, more socially liberal cosmopolitans and middle-class proponents of traditional American values.

These statistical patterns of voting at the individual and group level are central to political debates about

economic and social polarization. During a research project lasting several years, we resolved the statistical questions by fitting a series of multilevel models to study the differences in voting between rich and poor voters, and rich and poor states. We were using national survey data with relatively small samples in some states, ethnic groups and income categories; this motivated the use of Bayesian inference to partially pool between fitted models and local data.

Previous, non-Bayesian analyses of income and voting had failed to connect individual and state-level patterns. Typical analyses would be either at the individual or the aggregate levels but not both. In the studies that did model voting based on individual and geographic characteristics, the focus was on estimating some particular regression coefficient (or, more generally, on identification of some average causal effect). Classical statistics tends to focus on estimation or testing for a single parameter or low-dimensional vector, whereas Bayesian methods work particularly well when the goal is inference about a large number of un-

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certain quantities (in this case, coefficients within each of the fifty states).

Now that our analysis has been done, we believe it could be replicated using non-Bayesian methods: that is, with knowledge of the patterns we have found, one could fit a simpler, non-Bayesian model to estimate the interaction between individual and state incomes. However, one can also view our fitting of a series of models as a form of exploratory data analysis. It is only through active engagement with the data that we got a sense of what to look for. Thus, the flexible generality of the Bayesian approach facilitated our substantive research breakthrough here.

This is the opposite of the paradigm common in classical theoretical statistics, of laser-like focus on identification of a single effect and a concern with frequency properties of a prechosen statistical procedure.

Our Bayesian procedures are consistent with our political knowledge—that is, having obtained our estimates, we and others have been able to incorporate them into our understanding of income and voting (as discussed in detail by Gelman et al., 2009, where we consider various other factors including issue attitudes and religiosity as individual-level predictors). But this sort of theoretical coherence is not enough: social scientists are notoriously adept at coming up with explanations to fit any set of supposed facts. In addition, our model, as we have developed and extended it, fits the data via graphical checks (for an example, see Figure 3, which appears near the end of this article after we have described the model), and, perhaps convincingly, has performed well in external validation (in that we developed our models to fit to data from the 2000 election and then they successfully worked for 2004, 2008 and 2012).

The real world impact of this work is twofold. First, we have established that income is more strongly predictive of Republican voting in poor states than in rich states, and that this difference has arisen in the past two decades. Second, political scientists and journalists now have a clearer view of the relation between social, economic and political polarization. The political differences between “red America” and “blue America” are concentrated among the upper half of the income distribution. By allowing us to model a pattern of income and voting that varies across states, Bayesian analysis allowed us to get a grip on this important political trend.

2. BACKGROUND

For the past fifteen years or so, Americans have been divided politically into “red states” (the conservative,

Republican-leaning areas in the south and middle of the country) and “blue states” (the more urban areas in the northeast and west coast, whose residents consistently vote for Democrats). Here is the red-state, blue-state paradox: since the 1990s, the poorer states have voted for conservative Republicans while rich states favor liberal Democrats. This has surprised political observers, given that Republicans traditionally represent the rich with the Democrats representing the poor. And, indeed, Republican candidates do about 20 percentage points better among rich voters than among poor voters, a gap that has persisted for decades.

The red-state blue-state pattern became widely apparent in the aftermath of the disputed 2000 presidential election, when television viewers became all too familiar with the iconic electoral map: blue states on the coasts and upper midwest voting for Al Gore, red states in the American heartland supporting George Bush, and Florida colored blank awaiting the decision of the courts.

The result has confused political observers on both sides of the political spectrum. On the right came a much-discussed magazine article by David Brooks, comparing Montgomery County, Maryland, the liberal, upper-middle-class suburb where he and his friends live, to rural, conservative Franklin County, Pennsylvania, a short drive away but distant in attitudes and values, with “no Starbucks, no Pottery Barn, no Borders or Barnes & Noble,” plenty of churches but not so many Thai restaurants, “a lot fewer sun-dried-tomato concoctions on restaurant menus and a lot more meat-loaf platters.” On the left, Thomas Frank’s bestselling *What’s the Matter with Kansas* (2004) was widely interpreted to answer the question of why low-income Americans vote Republican: “For more than thirty-five years, American politics has followed a populist pattern . . . the average American, humble, long-suffering, working hard, and paying his taxes; and the liberal elite, the know-it-alls of Manhattan and Malibu, sipping their lattes as they lord it over the peasantry with their fancy college degrees and their friends in the judiciary.”

Here is a summary from Gelman (2011):

Republicans, who traditionally represented America’s elites, had dominated in lower-income areas in the South and Midwest and in unassuming suburbs, rather than in America’s glittering centers of power. What could explain this turnaround? The most direct story—hinted at by Brooks in

his articles and books on America's new, cosmopolitan, liberal upper class—is that the parties simply switched, with the new-look Democrats representing hedge-fund billionaires, college professors and other urban liberals, and Republicans getting the votes of middle-class middle Americans. This story of partisan reversal has received some attention from pundits. For example, TV talk show host Tucker Carlson said, “Okay, but here’s the fact that nobody ever, ever mentions—Democrats win rich people. Over \$100,000 in income, you are likely more than not to vote for Democrats. People never point that out. Rich people vote liberal.” And Michael Barone, the editor of the *Almanac of American Politics*, wrote that the Democratic Party “does not run very well among the common people.” But Tucker Carlson and Michael Barone were both wrong ... obviously wrong, from the standpoint of any political scientist who knows opinion polls. Republican candidates consistently do best among upper-income voters and worst at the low end. In the country as a whole and separately among Whites, Blacks, Hispanics and others, richer Americans are more likely to vote Republican. ...

Misconceptions about income and voting are all over the place in the serious popular press. For example, James Ledbetter in *Slate* claimed that “America’s rich now tilt politically left in their opinions.” In the *London Review of Books*, political theorist David Runciman wrote, “It is striking that the people who most dislike the whole idea of healthcare reform—the ones who think it is socialist, godless, a step on the road to a police state—are often the ones it seems designed to help. ... Right-wing politics has become a vehicle for channeling this popular anger against intellectual snobs. The result is that many of America’s poorest citizens have a deep emotional attachment to a party that serves the interests of its richest.” No, no and no. An analysis of opinion polls finds, perhaps unsurprisingly, but in contradiction to the above claims, that older and high-income voters are the groups that most strongly oppose health care reform.

It has been difficult for political journalists to accept that richer voters prefer Republicans while richer states lean Democratic. At first this may appear to be a simple example of the ecological fallacy: the correlation of income with Republican voting is negative at the aggregate level and positive at the individual level. And, indeed, part of the problem is a simple and familiar difficulty of statistical understanding, associated with people assuming that aggregates (in this case, states) have the properties of individuals. This misunderstanding is particularly relevant from a political perspective because the United States has a federal system of government, with some policies determined nationally and others at the state level. Thus, individual preferences and state averages are both important in considering politics and policy in this country.

3. STATISTICAL MODEL AND BAYESIAN INFERENCE: OVERVIEW

It turns out that the statistical story is more complicated too. Red states and blue states do not only differ in their political complexions; in addition, the relation between income and voting varies systematically by state. In richer, liberal states such as New York and California, there is essentially no correlation between income and voting—rich and poor vote the same way—while in conservative states such as Texas, the rich are much more Republican than the poor. Political divisions by social class look different in red and blue America.

This key statistical part of our analysis is the estimation of the relation between income and voting (later including religious attendance and ethnicity as additional explanatory factors) separately in each state. This is difficult because even a large national survey will not have a huge sample size in all fifty states—and recall that we are not merely estimating an average in each state but we are attempting to estimate a regression or even a nonlinear functional relationship. Political scientists armed with conventional statistical tools sometimes try to get around this sample size problem by pooling data from multiple years—but this would not work here because we are also interested in changes over time.

The Bayesian resolution was a multilevel model allowing different patterns of income and voting in different states. The model was built on a hierarchical logistic regression but included error terms at every level so that the ultimate fit was not constrained to fall along any parametric curve. Because of the complexity of our model, it was necessary to check its fit by comparing

data to posterior simulations. Classical approaches—even classical multilevel models—would not fully express the uncertainty in the fit. In contrast, our Bayesian approach not only allowed us to fit the data, it also provided a structure for us to consider a series of different models to explore the data.

In general, estimating state-level patterns from national polls requires two tasks: *survey weighting* or adjustment for known differences between sample and population (for example, surveys tend to overrepresent women, whites and older Americans, while underrepresenting young male ethnic minorities), and *small-area estimation* or regularized estimates for subsets where raw-data averages would be too noisy.

In order to estimate the pattern of income and voting within each state, we used the strategy of *multilevel regression and poststratification* (MRP), a general approach to survey inference for subsets of the population that has two steps:

1. Use a multilevel model to estimate the distribution of the outcome of interest (in this case, vote preference, among those people who plan to vote in the presidential election) given demographic and geographic predictors which divide the population into categories. Here we start with 250 cells (5 income categories within each of 50 states); a later model considers four ethnicity categories as well, and, more generally, the analysis could categorize people by sex, age, income, marital status, religion, religious attendance and so on, easily leading to more cells than survey respondents. It is the job of the Bayesian model to come up with a reasonable inference for the joint distribution of the Republican vote share within whatever categories are included.
2. Poststratify to sum the inferences across cells. For example, the estimated percentage of support for Obama among Hispanics in the midwest is simply the weighted average of his estimated support within each of the relevant poststratification cells (in the ethnicity/income/state model, this would be one cell for each income category within each midwestern state). The weights in this weighted average are simply the number of voters in each cell, which we can get from the U.S. Census. (To obtain voter weights is itself a two-stage process in which we first take the number of adult Americans in each cell, then multiply within each cell by the proportion of adults who voted, as estimated from a multilevel logistic regression fit to a Census post-election survey that asks about voting behavior; again, see Ghitza and Gelman, 2013, for details.)

It is clear how MRP fits in with Bayesian statistics: the number of observations per cell is small, so our problem is one of small-area estimation (Fay and Herriot, 1979), hence, it makes sense to partially pool inferences, averaging local data and a larger fitted regression model. Bayesian inference is a well-recognized tool for combining local information with predictions from a stochastic model (Clayton and Kaldor, 1987).

But it may be less obvious how our method connects with the vast literature on survey weighting, a field that traditionally draws a strong distinction between “model-based” procedures such as Bayesian or even likelihood methods that posit a probability model for the data and “design-based” inference which leave data unmodeled and apply a probability distribution only to the sampling process. The connection was made clear by Little (1991, 1993), who showed how model-based inference fits in a larger design-based framework (or, conversely, how design-based inferences are possible within a larger probability model). Little’s key insight is centered on the *poststratification identity*:

$$\theta = \frac{\sum_j N_j \theta_j}{\sum_j N_j},$$

where θ is some aggregate quantity of interest (for example, the estimated support for Obama among Hispanics in the midwest), j ’s are the cells within this aggregate, N_j is the population size of each cell (in our case, obtained from the Census), and θ_j is the (unknown) population quantity with the cell.

As noted, the above equation is a tautology. Its connection to statistical inference comes in the inferences for the θ_j ’s. Assuming simple random sampling within cells (the implied basis for classical survey weighting), one can estimate the θ_j ’s through simple raw cell means (statistically inefficient if sample sizes are small) or more effectively via regression modeling which quickly leads to Bayes if the number of cells is large and the model is realistically complex. The information that would go into classical survey weights instead enters our MRP calculations through the population sizes N_j . This is important: you can’t get something for nothing, and the cost of our poststratified lunch is the array of population numbers N_j .

MRP combines long-existing ideas in sample surveys but has become recently popular as a way to learn about state-level opinions from national polls (Gelman and Little, 1997; Lax and Phillips, 2009a, 2009b), perhaps as a result of increasing ease of handling large data sets as well as improvements in off-the-shelf hierarchical modeling tools. In many political science applications, state averages are of primary interest, and

we estimate opinion in within-state slices (for example, white women aged 30–44 in Missouri) only because we feel we need to, in order to adjust for differential nonresponse. We fit the multilevel model to get reasonable inferences within all these cells but then immediately poststratify to get state-level estimates. All these steps are needed—a simple Bayesian analysis of state-level data would fail to adjust for known demographic differences between sample and population. Modern surveys have large problems with nonrepresentativeness and some sort of adjustment is necessary to match the population. MRP forms a bridge between Bayesian inference (so flexible and powerful for estimating large numbers of parameters and making large numbers of uncertain predictions at once) and classical survey adjustment (given that real surveys can be clearly nonrepresentative of the population). This latter step is crucial in many applications in which data are combined from many disparate surveys.

In the Red State Blue State project, MRP plays a slightly different role. Here we actually are interested in categories within a state (initially, the five income categories; later, voters cross-classified by income, education and religious attendance). The poststratification is less important here (although it does come up: after we sum our inferences over cells within each state, we adjust our predictions of state-level averages to line up with actual recorded vote totals, a completely reasonable step given this additional information separate from the survey data). What is relevant for the present discussion is that our method harnesses the power of Bayes within a framework that accounts for concerns specific to survey sampling.

4. STATISTICAL MODEL AND BAYESIAN INFERENCE: DETAILS

We fit our models separately to pre-election poll data from 2000, 2004 and 2008, with about 20–40,000 respondents in each year. This sample size is large enough for us to estimate variation among states but not so large that we could just estimate each state's pattern using its own data alone. An intermediate approach would be to combine similar states, although one would not want to combine completely, and it would then make sense to fit a regression model to determine which states to combine, and also set some rule based on sample size to decide how much to pool each state . . . and this all leads to a multilevel regression.

For the purposes of learning about opinion from a sample, the multilevel model is a way to obtain estimates for mutually exclusive slices of the population

(and implicitly corresponds to the assumption that the respondents being analyzed are a simple random sample within each cell). From the perspective of statistical inference, however, our model is simply a hierarchical regression with discrete predictors. Thus, if we want to perform inference for 4 ethnicities \times 5 income categories \times 50 states, we just need to include predictors for ethnicities, income levels and states (along with various interactions), and perform inferences for the vector of regression coefficients, and inferences for the 1000 cells just pop out as predictions from the fitted regression model.

The most basic form of the model is a varying-intercept logistic regression of survey responses:

$$\Pr(y_i = 1) = \text{logit}^{-1}(\alpha_{j[i]} + X_i\beta),$$

where:

- $y_i = 1$ if respondent i intends to vote for the Republican candidate for president or 0 if he or she supports the Democrat (with those expressing no opinion excluded from the analysis),
- $\alpha_{j[i]}$ is a varying intercept for the state $j[i]$ where the respondent lives (that is, $j[i]$ is an index taking on a value between 1 and 50),
- X_i is a vector of demographic predictors (indicators for state, age, ethnicity, education and some of their interactions, and also income, discretized on a scale of $-2, -1, 0, 1, 2$), and β is a vector of estimated coefficients.

The intercepts α_j are themselves modeled by a regression:

$$\alpha_j \sim N(W_j\gamma, \sigma_\alpha^2),$$

where:

- W_j is a vector of state-level predictors (including average income of the residents of the state, Republican vote share in the previous presidential election and indicators for region of the country),
- γ is a vector of state-level coefficients, and
- σ_α is the standard deviation of the unexplained state-level variance.

We completed the Bayesian model by assigning to the otherwise unmodeled parameters β , γ , σ_α a uniform prior distributions: in retrospect, not the best choice (we do in fact have prior information on these quantities, starting with results from the model fit to earlier elections) but enough to give us reasonable results. As this work goes forward we plan to think harder about hyperprior distributions and additional levels of the hierarchy such as building in time-series models.

The varying-intercept model above fails because it assumes a constant relation between income and voting across states. Actually, the data show that income is much more highly correlated with Republican voting in some states than others. We fit this pattern using a model in which the intercept and the coefficient for individual income varies by state. The two varying coefficients within each state are then themselves modeled given state-level predictors and with a 2×2 covariance matrix for the state-level errors. (We coded income as -2 to 2 rather than $1-5$ so that the joint distribution of intercept and slope would be easier to model, following standard practice in regressions with interactions.) Figure 1 shows the models with constant slope and then with income coefficients varying by state. This new model fit reasonably well but we further elaborated it by adding varying coefficients for each income category, thus allowing a nonlinear relation (on the logistic scale) of income and vote preference that could vary by state and ethnicity. Income is included in this regression in three ways at once, but because of the hierarchical Bayesian model there is no multicollinearity problem.

Other versions of the model include additional individual-level predictors such as age, education and religious attendance. For some polls that are “self-weighting” or approximately so—this refers to sur-

veys where adjustments are made within the sampling process to minimize demographic differences between sample and population—we also sometimes fit models with fewer individual predictors. Ideally it makes sense to include important predictors such as sex, age and ethnicity in the poststratification to correct for sampling bias and variance in these dimensions, but for simplicity in computation and analysis we have also fit models including only income as a respondent-level variable.

The different pieces of the Bayesian predictive model for vote preferences connect in different ways to our statistical and substantive goals. Adjustments for sex, age, ethnicity and education correspond to survey weighting for these variables to correct for important known differences between sample and population. Including individual income as a predictor serves the goal of comparing the votes of rich and poor within states, while including state income as a group-level predictor allows us to compare rich and poor states. Finally, the varying-intercept model for state with its error term allows unexplained variation among states, which is crucial because we know that states vary in many other ways beyond that predicted by state income levels. The final model can be written in the form

$$E(y) \text{ within cell } j = \text{logit}^{-1}(W_j \gamma),$$

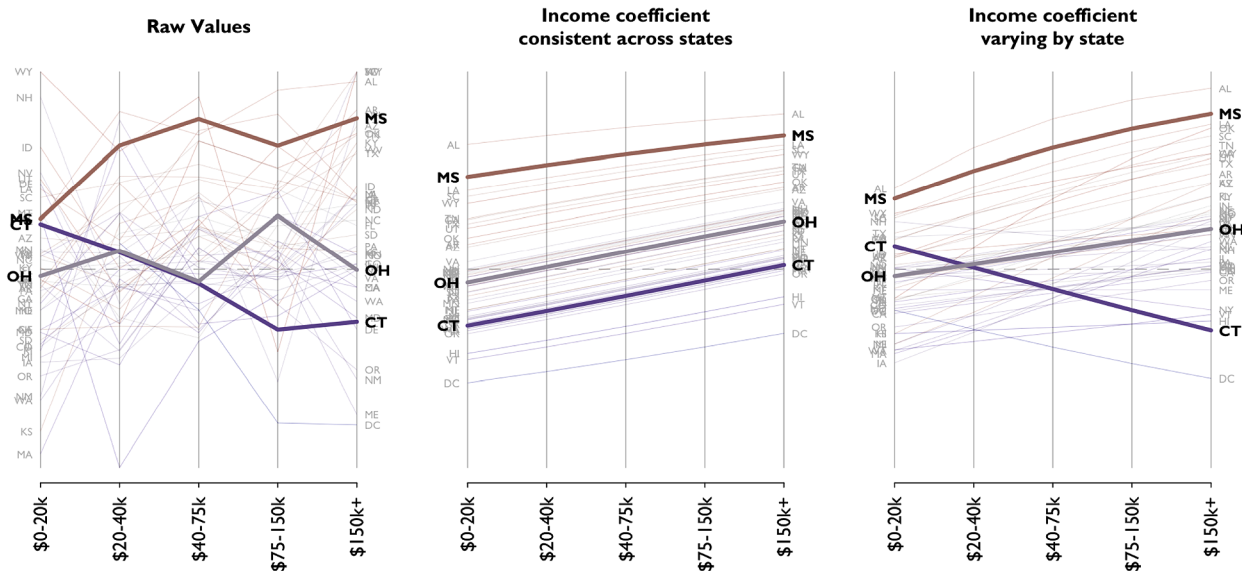


FIG. 1. The evolution of a simple model of vote choice in the 2008 election for state \times income subgroups, non-Hispanic whites only. The colors come from the 2008 election, with darker shades of red and blue for states that had larger margins in favor of McCain or Obama, respectively. The first panel shows the raw data; the middle panel is a hierarchical model where state coefficients vary but the (linear) income coefficient is held constant across states; the right panel allows the income coefficient to vary by state. Adding complexity to the model reveals weaknesses in inferences drawn from simpler versions of the model. The poorest state (Mississippi), a middle-income state (Ohio), and the richest state (Connecticut) are highlighted to show important trends. From Ghitza and Gelman (2013).

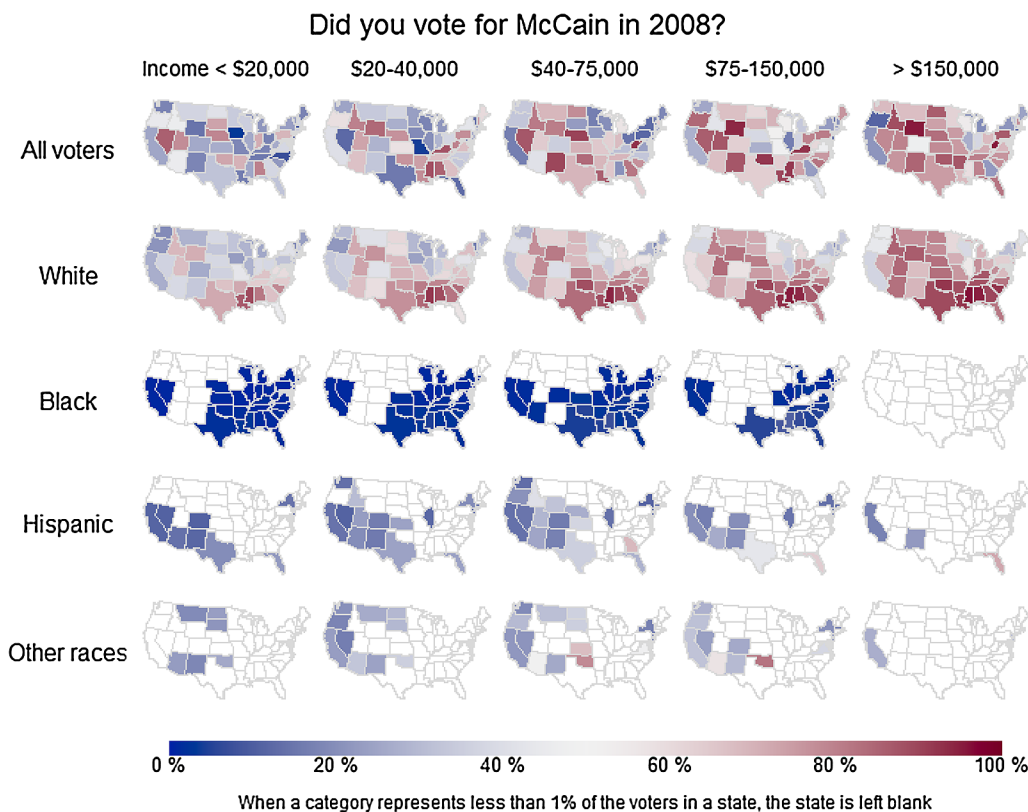


FIG. 2. *Estimated two-party vote share for John McCain in the 2009 presidential election, as estimated using multilevel modeling and poststratification from pre-election polls. Figure 3 displays some graphical diagnostics for comparing this fitted model to data. From Gelman, Lee and Ghitza (2010a).*

where j indexes the poststratification cell (states \times demographic variables), W is a matrix of indicator variables, and γ is a vector of logistic regression coefficients which themselves are modeled hierarchically, with batches of main effects and interactions. In the Bayesian analysis, posterior simulations are obtained on γ , which in turn induces a posterior distribution on the cell means, which are then combined by weighting with census numbers to obtain estimates for any subsets of the population. Figure 2 shows the resulting estimates of vote preferences by state, ethnicity and income for the 2008 presidential election.

The poststratification step points to a difference between our Bayesian solution and traditional statistical analyses. Even our basic model had many parameters but none of them mapped directly to our summaries of interest. To obtain the relation between income and voting within a state, we did not look at the coefficient for the income predictor. Rather, we used our model to estimate opinion in each poststratification cell and then summed up to infer about each income category within each state. Similarly, we compare rich and poor states not by focusing on the coefficient of

state income in the group-level regression but by using MRP to estimate the slope in each of the 50 states and then plotting the estimates vs. state income. The individual and state-level income coefficients are relevant to the model, but our ultimate inferences are constructed from pieced-together predictions. This sort of simulation-based inference may seem awkward to classically-trained statisticians but its flexibility makes it ideal for problems in political science where we are interested in studying variation rather than in estimating some sort of universal constant such as the speed of light. In addition, simulation-based estimates can be directly and easily expressed on the probability scale; there is no need to try to interpret log-odds or logistic regression coefficients.

5. GAINS FROM BAYES

Income and voting had been studied by political scientists for decades, but it was only through Bayesian methods that we were able to discover the different patterns of income and voting in rich and poor states, an important and exciting pattern that had never been

noticed before. At a technical level, our approach also accounted for the design of the survey data by adjusting for demographic factors that were used in survey weighting.

Often the key to a statistical method is not what it does with the data but, rather, what data it allows one to use. MRP combines design-based and model-based inference and can handle data from multiple surveys as well as census totals on demographics. As always, Bayesian inference works well with models with large numbers of parameters, allowing adjustment for many factors, which is another way of including more information in the inferential procedure. The complexity of the resulting inferences make it particularly important to graphically check the fit of model to data, as demonstrated in Figure 3.

We consider any multilevel model here to be Bayesian, even if it takes the form of a classical mixed-model in which the fixed effects and hierarchical variance parameters are estimated using marginal maximum likelihood. In the context of using surveys to estimate public opinion in geographic and demographic slices of the population, the inferences for quantities of interest are constructed from the estimated joint predictive distribution of the cell expectations. This summary of knowledge in the form of a probability distribution is the essence of Bayesian inference.

That said, we believe that an analysis just as good as ours could be constructed entirely using non-Bayesian methods. It would require a lot of extra work (for us) but it should be possible. In fact, many of the patterns we discovered (most notably, that income predicts Republican voting better in rich states than in poor states, and that religious attendance predicts Republican voting better among rich than poor voters) appear directly in the raw data—if you know to look for them. In that sense, multilevel Bayesian modeling (adapted to the sample survey context using poststratification) can be considered as an elaborate form of exploratory data analysis, giving us the chance to see patterns of complex interactions that are in the data but would not appear in simple regression models.

The key pieces in the Bayesian inference were: (a) weighted averages for small-area estimation; (b) poststratification, which detached the modeling stage of the analysis from the inferences for quantities of interest; (c) state-level predictors, which gave us reasonable estimates even for small states; (d) individual-level income included as a continuous and discrete variable at the same time, allowing a nonparametric

form for the income–voting relation but partially pooling to linearity; (e) and flexibility in modeling, letting us see the data and examine the problem from many different angles without the burden of requiring a fully-specified model. In standard statistical theory—Bayesian or otherwise—a model is either already built or is one of some discrete class of candidate models. In this sort of applied exploration, however, the model is always evolving, and it is helpful to have a statistical and computational framework in which we can explore different possibilities. The Bayesian framework is particularly open-ended in that adding complexity to the model is just a matter of adding parameters in the joint posterior distribution.

6. MOVING FORWARD

Our book that built upon the analysis described above has changed how journalists and political professionals think about the social and political bases of support for America’s two major political parties. For example, in 2009, political journalist and former presidential speechwriter David Frum described our book as “must reading”:

At first glance, American voting seems topsy-turvy. Super-wealthy communities like Beverly Hills, Aspen, and the Upper East Side of Manhattan vote Democratic. Meanwhile, Appalachia and Alaska are becoming ever more Republican. Republicans accuse the Democrats of “elitism.” Liberals wonder “what’s the matter with Kansas” and suspect low-income voters are either gullible or racist. Gelman deconstructs the paradox. . . . Most of us have the notion that issues such as abortion, same-sex marriage and immigration divide a more liberal, more permissive elite from a more traditionalist voting base: Bob Reiner vs. Joe the Plumber. Not so, says Gelman, and he has numbers to prove it. Downmarket voters are bread-and-butter voters. It is upper America that is divided on social issues: a more permissive, more liberal elite in the Northeast and California and a more religious, more conservative elite in the South and Midwest. It’s not Hollywood vs. Wassila. It’s Hollywood vs. the wealthy suburbs of Dallas and Houston and Atlanta.

2008 election: McCain share of the two-party vote in each income category within each state among all voters (gray) and just non-Hispanic whites (orange)

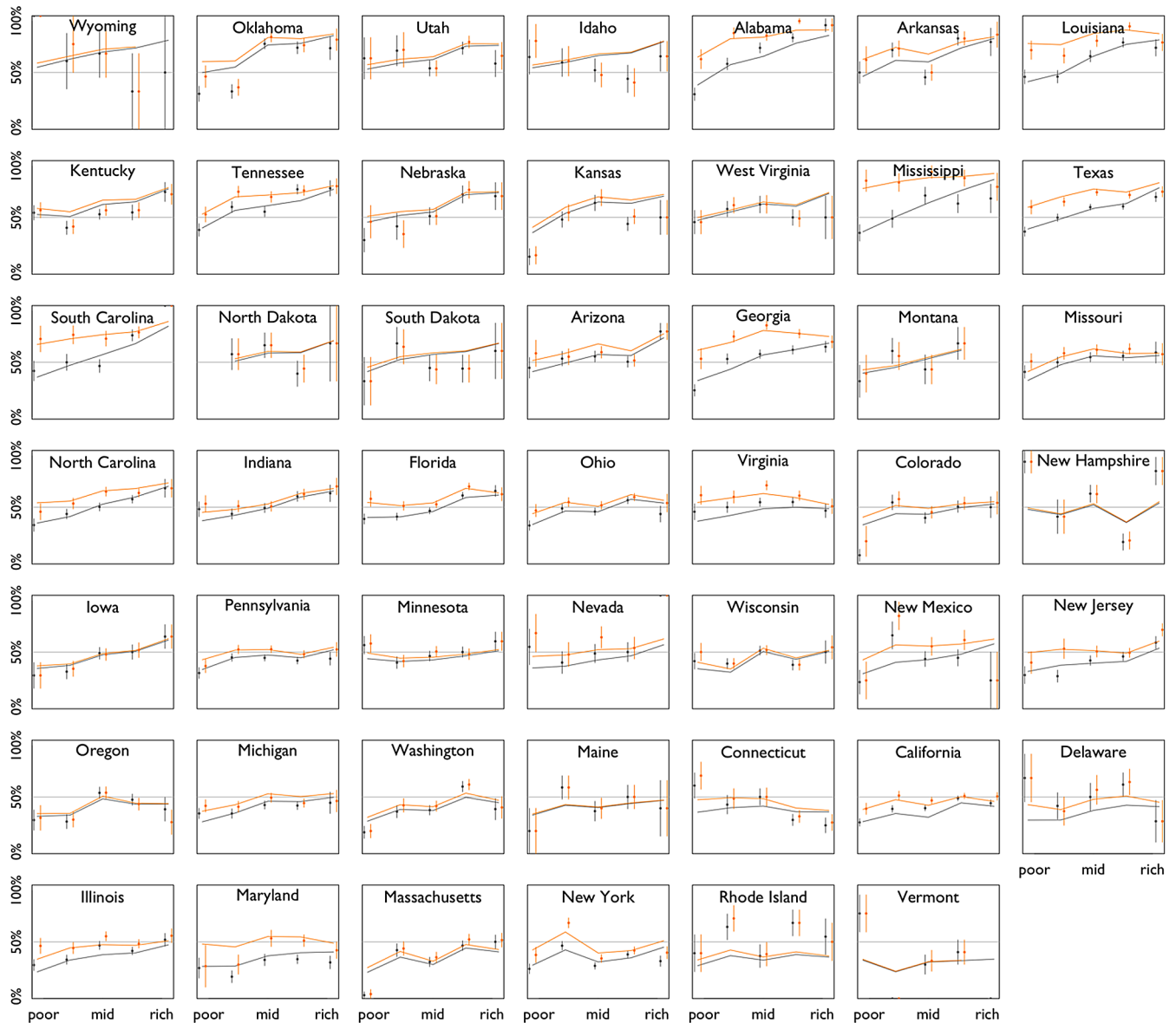


FIG. 3. Share of the two-party vote received by John McCain in each income category within each state among all voters (gray) and non-Hispanic whites (orange). Dots are weighted averages from pooled survey data from the five months before the election; error bars show ± 1 standard error bounds. Curves are estimated using multilevel models and have a standard error of about 3% at each point. States are ordered in decreasing order of McCain vote share (Alaska, Hawaii and the District of Columbia excluded). From Ghitza and Gelman (2013).

This new understanding is, we hope, replacing the more simplistic attitudes of rich Democrats and down-to-earth Republicans as expressed by various pundits in Section 2 of this article.

The success of our red-state–blue-state analysis also motivated ourselves and others to apply MRP in a variety of settings to understand local attitudes and to integrate demographic and geographic modeling in social science, on topics related to health care (Gelman, Lee

and Ghitza, 2010b), capital punishment (Shirley and Gelman, 2014), gay rights (Lax and Phillips, 2009a) and more general questions of the relation between state-level opinion and state policies (Lax and Phillips, 2012). To the extent that public opinion can be estimated at the state level and this is done for topical issues, this can inform public debate, as, for example, with the recent Senate vote on the Employment Nondiscrimination Act (Lax and Phillips, 2013).

On a more methodological level, many statistical challenges remain with MRP, most notably how to build and compute models with many predictive factors (age, ethnicity, education, family structure, ...) and correspondingly huge numbers of interactions, how to visualize such model fits, and how to poststratify on characteristics such as religious attendance that are not known in the population. More generally, our increasing ability to fit large statistical models puts more of a burden on checking and understanding these models. Given that a mere two-way model of income and state turned out to be complicated enough to require a multi-year research project, we anticipate new challenges in digesting larger models that allow more accurate inferences from sample to population.

ACKNOWLEDGMENTS

Partially supported by the National Science Foundation and Institute of Education Sciences. We thank Yair Ghitza and two reviewers for helpful comments, and Christian Robert and Kerrie Mengersen for organizing this special issue.

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