

## Appendix to: “Unions, Voter Turnout, and Class Bias in the U.S. Electorate, 1964-2004”

### Computing Aggregate Turnout Decline

In the body of the paper we demonstrated how we could compute first differences for a given respondent: by changing the value of one or more of the independent variables (whether state level or national level union strength, or union membership), we were able to estimate the affect of changes in union strength on individual respondents. To estimate the aggregate change caused by the change in union strength we need to estimate the effect of a change in union strength over a representative sample of voters, and aggregate our results. And since our model contains state-level variables, we must do this for each state, then aggregate over the 50 states to get national estimates.

Now in going from a non-linear individual model to aggregate estimates we need some approximation of the characteristics of the respondents we will aggregate over. Our individual level model relates respondent characteristics to estimated probability as:  $\hat{P}_i^* = F(X_i\hat{\beta})$ . Thus for each state, we do not actually need the distribution of the respondents' characteristics (the  $X$ s), but we only need the distribution of  $X_i\hat{\beta}$ . We do not observe this distribution, but we can estimate it. We do this as follows. We observe the distribution of  $\hat{P}_i^*$  nationally from the NES. This means that we could compute the standard deviation of this, the sample standard deviation from our 1500 or so NES respondents for 2004 (i.e., we compute the standard deviation over  $\hat{P}_1^*, \hat{P}_2^*, \dots, \hat{P}_{1500}^*$ ). Call this  $\hat{\sigma}_{nes}$ . So we have  $\hat{P}_i^*$  nationally distributed as  $N(\bar{P}^*, \hat{\sigma}_{nes})$ . For each state, we need  $\bar{P}_s^*$  so that we can compute  $\overline{X_i\hat{\beta}}$ . While we do not observe reported state turnout with any meaningful accuracy, we do observe actual state turnout, as well as actual national turnout. These numbers are available as part of the officially reported vote totals and population data from secretary of state's offices, and have been compiled through 1996 by the Congressional Research Service and have been compiled through the 2004 election by Michael McDonald (Crocker 1996, 1997; McDonald 2005). To

estimate each state's reported level of turnout, we assume that: the ratio of the odds-ratio of reported turnout in a given state to the odds-ratio of actual turnout in the state is equal to the ratio of the odds-ratio of reported turnout nationally to the odds-ratio of actual turnout nationally.<sup>1</sup> Similarly, to estimate the reported turnout of each income group within each state we assume that the ratio of the odds-ratio for reported turnout of each income group to the odds-ratio of reported turnout of the entire state is equal to the ratio of the odds-ratio for reported turnout nationally of each income group to the odds-ratio of reported turnout nationally. We again estimate the national ratios using the NES, and this allows us to compute the state-specific quantities we need:  $\bar{P}_{k,s}^*$ . From  $\bar{P}_{k,s}^*$ , we can compute  $\overline{X_{k,i}\hat{\beta}_s}$  by taking  $F^{-1}(\bar{P}_{k,s}^*)$ .

Formally, we assume:

$$\frac{\bar{OR}_s^*}{OR_s} = \frac{\bar{OR}_{usa}^*}{OR_{usa}} \quad (1)$$

and:

$$\frac{\bar{OR}_{k,s}^*}{OR_s^*} = \frac{\bar{OR}_{k,usa}^*}{OR_{usa}^*} \quad (2)$$

where:

- $\bar{OR}_s^*$  is odds ratio for overall reported turnout in state  $s$
- $\bar{OR}_s$  is odds ratio for overall actual turnout in state  $s$
- $\bar{OR}_{usa}^*$  is the odds ratio for overall national reported turnout
- $\bar{OR}_{usa}$  is the odds ratio for overall national actual turnout
- $\bar{OR}_{k,s}^*$  is odds ratio for reported turnout of the  $k^{th}$  group in state  $s$
- $\bar{OR}_{k,usa}^*$  is the odds ratio for national reported turnout of the  $k^{th}$  group

As we stated above, we compute the standard deviation of the sample standard deviation from our 1500 or so NES respondents for 2004 to get  $\hat{\sigma}_{nes}$ . However, mathematically it is much easier to work with  $X_i\hat{\beta}$  than to work with  $\hat{P}_i^*$ . So, we compute the standard deviation of  $X_i\hat{\beta}$  for the 2004 NES. And for any state, we compute  $\overline{X_{k,i}\hat{\beta}}$  as the inverse-scobit transformation of  $\overline{P_{k,s}^*}$ . We assume that for any state,  $X_{k,i}\hat{\beta}$  is distributed as:  $\mathbf{N}(\overline{X_{k,i}\hat{\beta}}, \sigma_{X_i\hat{\beta}, nes}^2)$ .

Now, to compute the estimated change in turnout of a given income group  $k$  for a given state (thus the  $s$  subscript is suppressed in the notation) given the change in union density from the state's 1964 level to its 2004 level, we:

1. Draw 10,000 values of  $X_{k,i}\hat{\beta}$  from  $\mathbf{N}(\overline{X_{k,i}\hat{\beta}}, \sigma_{X_i\hat{\beta}, nes}^2)$ : this gives us a representative sample of respondents from each state.
2. Adjust each value of  $X_{k,i}\hat{\beta}$  as follows:
  - Changing the value of union-density for the nation from union-density(2004) to union-density(1964), multiply this by  $\hat{\beta}_{national\_union\_density}$  and add this to  $X_{k,i}\hat{\beta}$ .
  - Changing the value of union-density for the state from union-density(s,2004) to union-density(s,1964), multiply this by  $\hat{\beta}_{state\_union\_density}$  and add this to  $X_{k,i}\hat{\beta}$ .
  - Assign a random number of respondents to be union members such that the proportion of union members in the state matches the 1964 proportion of union members for income group  $k$ . Add  $\hat{\beta}_{k,union\_member}$  to each such respondent's value of  $X_{k,i}\hat{\beta}$ .
3. This gives us new values,  $\tilde{X}_{k,i}\hat{\beta}$  for each hypothetical respondent in the state.
4. Compute  $\hat{P}_{k,i}^*$  corresponding to each adjusted value of  $X_{k,i}\hat{\beta}$  ( $\tilde{X}_{k,i}\hat{\beta}$ ) from the step above.
5. Compute the mean of  $\hat{P}_{k,i}^*$ .

This gives us change for each income group within each state. We then simply sum over the states, weighting by the state's share of voting age population to get national change.

## **References**

Crocker, Royce. 1996. "Voter Registration and Turnout: 1948-1994", Congressional Research Service.

Crocker, Royce. 1997. "Voter Registration and Turnout: 1996", Congressional Research Service.

McDonald, Michael. 2005. "United States Election Project." Accessed December 2005.  
[http://elections.gmu.edu/voter\\_turnout.htm](http://elections.gmu.edu/voter_turnout.htm)