Key Words: Exit polling, categorical data analysis, contingency tables, log-linear models

Introduction

Elections have been a part of the American political system for more than 200 years. Elections are a vital and interesting part of the American political scene, and because of the interest elections generate, people want to know who has won the election as soon as possible. Exit polls in part, have been adopted as a popular tool to meet that need.

Early projections of winners have raised concern and have led to severe criticism of exit polls. One criticism is that early projections from data on the East Coast can influence the way people vote and whether they will vote on returns and early projections could show a Democratic leaning. This could affect both Democratic and Republican voters on the West Coast who hear the early projection.

What, if any, is the relationship between the time of day an individual votes and the way that individual votes? Is there any evidence to conclude that voters of one political persuasion vote at a different time of day than those of a different political persuasion? An early poll, if conducted the right way, with the right questions being asked, can provide the answer. If interviewers interview throughout the day, and the time of day an individual votes is recorded, the relationship between time and vote can be investigated.

To date, few studies dealing with time of voting and voting patterns have been done. A study done by Klorman (1976), using aggregate national data, examined various demographic variables and their relationship to time. Using indices of dissimilarity and the canonical correlation of dummy variables based on three sets of variables, he concluded that although relationships seem to exist across subpopulations based on demographic variables, when the population is looked at as a whole, the relationships tend to cancel each other out. He does suggest that dividing the population into subpopulations, using interactions between various variables, might do a better job of predicting voting behavior across time, but because of small sample sizes he was not able to pursue the issue.

A study done by Busch (1985) disagrees with Klorman's findings. Busch argues that Klorman's use of national data may minimize any effect of time in a specific area of the country. This is because characteristics in one part of the country may be reversed in another part of the country so that any overall effect is negligible. Using exit poll data taken from a special election held in Cleveland, Ohio, he concludes that the amount of discretionary time a voter has, affects their time of voting. Busch also explains other differences in voting behavior that were observed. He argues however, that if the election were held across the whole country, different metropolitan areas might cancel out any significant effect that was seen in a local area. He concludes that the time of exit poll interviews can affect exit poll results in local areas because different people are voting at different times.

The purpose of this study is to investigate the relationship between the time one votes and the way one votes using data from an exit poll conducted by students at Brigham Young University (BYU). Insofar as is possible we have tried to duplicate the analysis methods of Busch and Klorman for purposes of comparison.

Exit Poll Methodology

Exit polls have been conducted at BYU in 1982, 1984, 1986, and 1988. For this study we have used only the 1988 data. The exit poll conducted in 1988 by BYU students was a stratified, multi-stage probability sample with some counties and all voting districts selected with probabilities proportional to size. Individual voters were selected systematically within a voting place using a random start.

Utah is divided into three congressional districts. Therefore these districts were used as the basis for developing the sample design. Eight counties were included in the sample with certainty because of location, past voting behavior, or size (these counties are referred to as certainty units--selected with probability equal to one). The remaining counties were grouped into 3 strata. From these, three counties from congressional district 1 and three counties from congressional district 3 were sampled with probability proportional to size. The counties included in the sample are shown as "shaded" counties in Figure 1.

A total of 120 polling locations across the state were used, 40 locations per congressional district. Then, based on the counties sampled in the first stage, voting locations within each congressional district were allocated proportionately, based on estimated voter turnout, for the selected counties. The number of polling locations sampled is also shown in Figure 1 beneath the county name.

Once the sample counties were known, an estimate of voter turnout for each voting location within each selected county was obtained using past election data. Based on the projections of voter turnout, polling locations were selected using pps sampling. In each county sampled, at least two locations were selected so that a measure of within-county variance could be obtained.

After polling locations were selected, the projected voter turnout for the location was used to establish voter sampling rates to produce a self-weighting sample. Thus, theoretically, every voter had an equal chance of being selected. Estimates of totals or means then become a constant multiplied by the sum of all the individual responses across the voting locations, counties and strata of interest.

Comparison With Busch's Study

Busch (1985) published results obtained in 1981 from a special election held in Cleveland, Ohio. This election dealt with a measure that would increase the city's income tax. Using data obtained from an exit poll, Busch used two and three-way tables as well as dissimilarity indices for his analysis. For his purposes, the election day was divided into five equal periods: (1) early morning (6:30 A.M. to 9:00 A.M.), (2) midmorning (9:00 A.M. to 11:30 A.M.), (3) noon (11:30 A.M. to 2:00 P.M.), (4) midafternoon (2:00 P.M. to 4:30 P.M.), and (5) late afternoon (4:30 P.M. to 7:00 P.M.). Next, Busch broke the population down by employment, sex, occupational status, education, age, race, party identification, and how they voted in the election.

Data taken from the BYU exit poll conducted by BYU students during the 1988 elections was divided by the same time intervals and the same demographic variables resulting in Table 1. (Employment and occupational status were not obtained from respondents and are therefore excluded from the analysis). Table 1 shows the proportion of voters within


each time period based on demographic variables. During the 1988 elections, three tax initiatives (A, B, and C) were on the ballot. The tax initiative closest in time to the time period of voting was chosen as most comparable with the tax measure examined by Busch. Cramer's V is used as a measure of association to compare with values obtained by Busch. Significance levels are also given based on a chi-square test for homogeneity across time intervals. These significance levels are valid assuming the data is obtained from a simple random sample. This obviously is not the case since our sample is a stratified multi-stage sample. However, we found that the estimated variances (based on our sample design) of several characteristics were not much different than variances expected assuming that the data had come from a simple random sample rather than a stratified multi-stage sample. This leads to a design effect\(^2\) close to 1. A design effect close to 1 would suggest that the contribution to the variability of the design under consideration is not much different than that which is expected under simple random sampling. For this reason, we include p-values as a measure of significance with the expectation that the statistical properties will not differ seriously from that of a simple random sample. This argument and interpretation applies to all sections of this article where p-values are cited or used.

One area of concern in Table 1 comes about because Busch's time intervals exaggerate the proportion of voters in the fifth time interval, since interviews were conducted over a different time frame in Utah (from 7:00 A.M. to 8:30 P.M. as compared to 6:30 A.M. to 7:00 P.M. for Busch). Therefore, Table 2 is produced using different time intervals. A post stratification procedure proposed by Cochran (pp. 127-131) was used so that the number of respondents sampled within each time interval was approximately the same. In keeping with Busch's analysis five time intervals were created: (1) early morning (7:00 A.M. to 9:30 A.M.) (2) midmorning (9:30 A.M. to 12:15 P.M.) (3) noon (12:15 P.M. to 3:00 P.M.) (4) afternoon (3:00 P.M. to 5:30 P.M.) (5) evening (5:30 P.M. to 8:30 P.M.) were used from 7:00 A.M. to 8:30 P.M. for Busch). Comparing Tables 1 and 2, we can see that whether Busch's or BYU's time intervals are used, Cramer's V obtained for the BYU data is smaller than that obtained by Busch. The p-values (on Cramer's V) for tax initiative A are the only ones that are not small. It is important to note while each p-value there is some relationship with time of voting exists, the amount of association is not high. The small p-values may be the result of the large sample sizes. Even so, the variable of real interest, tax initiative A, is not statistically significant across time. These relationships support Klorman's conclusions that there is no voting pattern across the time of day. However, even though voting for initiative A does not change significantly across time of day, it may still be influential when voting for initiative A is examined across smaller demographic subdivisions.

Busch's other measure for homogeneity across time and subpopulations is a dissimilarity index. This index is defined as the measure of inequality in the cumulative distributions of two variables, in this case any two levels of the demographic variables being examined. For our data, it represents the proportion of voters that would have to shift in the time period they voted so that the distributions of the two levels being examined would be the same. These indices are found in Table 3.
Using dissimilarity indices, Busch subjectively concludes that there is a difference in voting patterns across time. Specifically, he identifies the most dissimilar subgroups as those with the most discretionary time or those with irregular working hours. These groups include the unemployed, unskilled, grade school educated, college educated, professional, and voters over the age of 65. Based on results obtained from the BYU exit poll, the most dissimilar groups include voters with only an 8th grade education, those over 55 years of age, and black voters. It should be noted that these groups were chosen as dissimilar based on the magnitude of their dissimilarity indices. If a Smirnov test is used to test for differences in the distribution functions, the only statistically significant differences exist between age groups 6 (65 years of age and older) and the rest, and 5 (55-64 years of age) and the rest (this test and the results are shown in the Appendix). All other differences between subpopulations are not significant.

One reason for dissimilarity may be attributed to the small samples obtained in these subgroups relative to the rest of the population. With BYU's data, for example, those with just an eighth grade education accounted for only 0.8% of interviewed voters, and blacks accounted for only 0.46% of interviewed voters. This leaves voters over the age of 55 as the only dissimilar group worthy of note from the exit poll data set.

The dissimilarity index for initiative A is 2.2 which indicates that 2.2% of voters would have to change the time period in which they voted in order to make the distributions of those voting for and against initiative A equal. These results support Klorman's conclusions.

In the next two sections we examine the exit poll data using log-linear models and analysis of variance to bring more sophisticated and powerful methods to bear on our analysis.

Analysis Using Log-Linear Models

Like the analysis in the previous section, the log-linear analysis used here does not deal with any simultaneous interrelationships between age, education, sex, party, or race because the sample sizes were too small in the resulting cross tabulations.

Models were fit using sex, age, education, party, and race, each in separate models in conjunction with time of voting as population variables in each of the models. In each case, the response variable was vote for tax initiative A. The purpose of these models was to test hypotheses about homogeneity of voting (V) for initiative A across the possible combinations of the population variables sex (S), age (A), education (D), party (P), race (R), and time (T). The reduced models associated with this analysis and their corresponding lack-of-fit tests and logits (expected probabilities) are shown in Table 4.

One conclusion that all of these models support is that there is not a significant relationship between the time when people vote and the way they voted for initiative A. This relationship is represented by the TV term and three-way interactions (STV, ATV, DTV, PTV, and RTV) in each of the saturated log-linear models. In each case these terms were not significant (based on $\alpha=.05$) as is shown by the lack-of-fit tests in Table 4. This conclusion would correspond to the conclusions made in the previous section dealing with the effect of time on voting for Initiative A. In the case of sex, age, and party affiliation, the level of the variable was related to when people voted but not how they cast their votes. Therefore, across time, within a level of the above variables, voting for tax initiative A was apparently homogeneous. The reduced models for education and race indicate that the only difference existing is the actual vote for initiative A. The results of these models are shown graphically in figures 2-6.

Despite evidence that no relationship exists between time of voting and exit poll results, smaller subpopulations or interactions between age, education, etc. still have not been examined. This could not be handled using the preceding procedure because of small sample sizes, missing cells within subpopulations, and computer storage limitations restrict the above analysis.

Analysis of Variance

Thus far, time-of-interview has been used as an independent categorical variable in an effort to predict how an individual would vote for Tax Initiative A. However, when the data was collected, the time-of-interview was recorded as a semi-continuous variable.$^4$ Therefore, time can also be considered as the dependent variable with characteristics of voter behavior used as independent variables (sex, education, vote for Initiative A, vote for president, etc.). This is the setup for an analysis of variance where the time a person votes is the dependent variable. However this data was not collected from a designed experiment but rather an observational study. Because of this, no causality can be proved between dependent variables and time of voting. For purposes of this analysis, interactions to be included in the model were limited to two and three-way interactions (all higher order interactions are assumed to be negligible). The initial model uses time-of-voting (Y) as the dependent variable and vote (T) for initiative A, vote (G) for the gubernatorial race, age (A), party (P), sex (S), and education level (D) as independent variables. County (C) was included as a blocking variable. The resulting model is written as:

$$Y = TAXA(T) + GOVN(G) + AGE(A) + PARTY(P) + SEX(S) + EDUC(D) + TG + GA + GP + GS + GD + AS + PS + SD + AP + AD + PD + TS + TA + TP + TD + APS + ASD + APD + PSD + TAS + TPS + TSD + TAP + TDP + GAP + GPS + GSD + GAP + GAD + GDP + TGS + TGA + TGP + TGD + CTY(C) + E.$$
effect of local areas above the effect of other variables in the model. This is in response to Busch's argument that time of voting may effect election results differently across areas of the country. Because CTY is not significant, the effect of time does not appear to differ across the counties sampled. This supports Korman's study across many locations. The model was highly unbalanced, therefore use of RUMMAGE (Bryce, 1980), a computer program for unbalanced data, was used. As can be seen from the AOV table in Table 5, all terms below the TAX by GOVN interaction do not appear to help predict the time a person would vote. These terms were dropped from the model and the reduced model\(^5\)

\[
Y = \text{AGE(A)} + \text{TAX(T)} + \text{GOVN(G)} + \text{TG} + E
\]

was fit and a partial F calculated to test for the significance of the terms dropped from the full model above. The sums of squares and partial F calculation are found in Table 6. As can be seen, F(344,1298) = .878 which has a p-value of .93. This test justifies the model above. Because of the small size of the sums of squares for T (vote for initiatives A, G (vote for the gubernatorial race), and TG (the interaction between voting for initiative A and voting for the gubernatorial race) relative to the sums of squares for age, all other models that included two-way interactions and age were examined for significance of the interaction. This was done in order to justify including TG in the model relative to all other two-way interactions. In each of the other models the two-way interactions were found to be non-significant for \(\alpha = .05\). This gave support for the above reduced model which includes TG\(^5\). Even with the significance of the model

\[
Y = \text{AGE(A)} + \text{TAX(T)} + \text{GOVN(G)} + \text{TG} + E
\]

The major drawbacks of dissimilarity indices and log-linear models are their inability to check for significant relationships or interactions between time and the demographic variables. Because of the sample sizes necessary in the subpopulations, these methods were limited to separately examining the demographic variables and not their interactions with each other.

Future research should work towards solving the above problem as well as examining other ballot issues such as the more partisan issues, i.e. senatorial races, presidential races, etc.
Exit polls are conducted the day of the election by interviewing voters as they leave the polls. The voters are asked how they voted as well as demographic and other voter-related questions. Exit polls are predominantly conducted by the media and political scientists. The media’s primary interest is early projections while political scientists are interested in voting behavior. CBS first introduced exit polls in 1967 (Bogart 1985; Levy 1983); but exit polls received little credibility until 1972 when the three major networks pooled their strengths with major newspapers. Since that time, exit polls have been conducted for nearly every general and primary election.

The design effect for a given random variable X is the ratio of the variance of that random variable for the design under consideration to the variance of the same variable assuming simple random sampling. That is,

\[ \text{Design Effect} (X)_{\text{DESIGN}} = \frac{\text{Variance of } X_{\text{DESIGN}}}{\text{Variance of } X_{\text{SIMPLE RANDOM SAMPLING}}} \]

The index is calculated using the following formula (Busch, 1985):

\[ D = \frac{1}{k} \sum_{i=1}^{k} |X_i - Y_i| \]

For example, using the data from Table 1 for Sex results in the following index calculation:

\[ D = \frac{1}{2} \left( |216.6 - 16.0| + |17.7 - 22.0| + |18.7 - 21.7| + |21.3 - 20.2| + |20.7 - 20.1| \right) = 7.3 \]

This index says that in order for the cumulative distributions of males and females voting within each time interval are within 7.3% of each other.

Since time was recorded based on the hour and minute, 700-759, 800-859, 900-959, etc., discontinuities exist every 60 minutes from 760-799, 860-899, etc. Therefore, minutes were put on a scale from 1-100 rather than 1-60.

It should be noted that due to missing values, 204 observations were deleted from the full model. Therefore, for consistency, these observations were not included for the calculations involving the reduced model. When analysis was performed on these 204 observations, education level is significant with all other possible terms negligible including age, tax initiative A and gubernatorial race.

Generally, the average time of voting was about the same (1:30 p.m.) across the Tax*GOVN interaction except for one group voting for Cook and against initiative A. Their average time of voting was almost an hour later.

References

In order to carry out a k-sample Smirnov test, the following assumptions should be met:
1. The samples are random and independent.
2. The measurement scale is at least ordinal.
3. The data should be continuous otherwise the test will be conservative.

In this case the samples are independent and random; and the measurement scale, time period of interview, is ordinal. However time period is not continuous therefore the test will be conservative.

The hypothesis tested by the Smirnov test is that the population distribution functions are the same for each distribution.

\[ H_0: F_1(x) = F_2(x) = F_3(x) = \ldots = F_k(x) \]
\[ H_1: F_i(x) \neq F_j(x) \text{ for some } i, j, \text{ and } x \] where i and j are levels of x

The test statistic is \( T = \sup [S(1)(x) - S(k)(x)] \), the greatest vertical distance between \( S(1)(x) \) and \( S(k)(x) \).

In order to perform this test, the sample distribution functions are presented in Table 1A. The maximum differences are marked by asterisks for each characteristic. Since sample sizes are not equal, the sample with the smallest size was used in determining the significance of the test. Based on the distribution functions shown in Table 1A, Age is the only characteristic for which there exist significant differences in the distribution functions. In this case, those over age 65 are significantly different from all other age groups. Given the large difference between those in the 55-64 age group and the younger age groups, a significant difference exists between these groups, but the difference among the first four age groups is not significant.

Table 1A

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* \( S(1)(x) \)
* * \( S(2)(x) \)
** \( S(3)(x) \)

\[ \text{Sex: } S(\text{Male})(1) - S(\text{Female})(1) = .056 N=826 \]
\[ \text{Educ: } S(\text{8th grade})(2) - S(\text{Some College})(2) = .291 N=14 \]
\[ \text{Age: } S(65+)(3) - S(25-34)(3) = .244 N=101 \]
\[ \text{Race: } S(\text{Other})(4) - S(\text{Black})(4) = .299 N=663 \]
\[ \text{Party: } S(\text{Dem.})(2) - S(\text{Rep.})(2) = .021 N=328 \]

Appendix