Compositional data analysis of vote shares in the 2001 Australian Federal election

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Context

- Geospatial modelling has investigated spatial voting patterns in Federal elections
- We are interested in investigating the determinants of voting outcomes at the electoral division level
- We hypothesise that voting outcomes are related to the characteristics of the electoral divisions
- We will focus upon first preference voting for The House of Representatives in the 2001 Federal election
Data

• 2001 Federal election took place three months after the 2001 census
• Thus we have an ideal match between the voting data and census data on the characteristics of the electoral divisions.
• We use Australian Electoral Commission data for the 150 electoral divisions on the vote shares of six parties
  – Coalition, ALP, Democrats, Greens, ONP and Others
• This is matched to census data on characteristics of the electoral division
Compositional data analysis

• Use the additive log-ratio transformation and fit a multivariate regression model to the transformed data:

\[
y_i = \ln \left( \frac{s_i}{s_n} \right) = \mu_i (Z, \theta) + u_i = Z'_i \theta_i + u_i, \]

\[
\mathbf{u} = [u_i] \sim N(0, \Sigma).
\]

• Can invert to return to vote shares.
Zeros in compositional data analysis

- Cannot take the log of zero
- Solution is to use “modified Aitchison” with minimum (sensible) replacement values
- We will assume that when we observe a zero we can replace it with a one
  - That is, should the parties have stood then the candidates would have voted for themselves
- Check for robustness of estimates to the zero replacement procedure
Results

• Estimates make sense and are well determined.
• Robust to changing the the zero replacement (1, 2, 3, 5, 10, 20 or 50 votes)
• Correctly classify 139 of 150 electoral divisions
  – New England predicted Coalition actually Independent
    • AEC classified as Safe National Party
  – Of the six predicted ALP but actually Coalition all were classified by the AEC as marginal ALP
  – Of the four predicted Coalition but actually ALP three were classified by the AEC as marginal (ALP and Liberal)
Results

• We can use our estimated model to give us the estimated votes by electoral division
  – For a party that did not contest an electorate (e.g. ONP) this is an estimate of the vote that they might have obtained had they stood
  – IF the party (ONP) makes rational decisions then the vote in electorates that it does contest is larger than that in which it does not stand a candidate.
    • t-test statistic is 8.8179
Conclusions

• First application of compositional data analysis techniques to Australian election data
• Still need to fine tune the work – but results are encouraging
• Also working on a number of related issues concerning functional forms and zero replacement in compositional data analysis