Problem Set 3

Applied Stats II

Due: March 24, 2024

Instructions

- Please show your work! You may lose points by simply writing in the answer. If the problem requires you to execute commands in `R`, please include the code you used to get your answers. Please also include the `.R` file that contains your code. If you are not sure if work needs to be shown for a particular problem, please ask.
- Your homework should be submitted electronically on GitHub in `.pdf` form.
- This problem set is due before 23:59 on Sunday March 24, 2024. No late assignments will be accepted.

Question 1

We are interested in how governments' management of public resources impacts economic prosperity. Our data come from Alvarez, Cheibub, Limongi, and Przeworski (1996) and is labelled `gdpChange.csv` on GitHub. The dataset covers 135 countries observed between 1950 or the year of independence or the first year forwhich data on economic growth are available ("entry year"), and 1990 or the last year for which data on economic growth are available ("exit year"). The unit of analysis is a particular country during a particular year, for a total > 3,500 observations.

- Response variable:
  - `GDPWdiff`: Difference in GDP between year t and $t-1$. Possible categories include: "positive", "negative", or "no change"
- Explanatory variables:
  - `REG`: 1=Democracy; 0=Non-Democracy
  - `OIL`: 1=if the average ratio of fuel exports to total exports in 1984-86 exceeded 50%; 0= otherwise

Please answer the following questions:

1. Construct and interpret an unordered multinomial logit with `GDPWdiff` as the output and "no change" as the reference category, including the estimated cutoff points and coefficients.

```r

# Reorganise factors

gdp_data$GDPWdiff_New <- factor(ifelse(gdp_data$GDPWdiff > 0, "positive", ifelse(gdp_data$GDPWdiff < 0, "negative", "no change")),
levels = c("positive", "no change", "negative"),
labels = c("positive", "no change", "negative"))

gdp_data$REG <- factor(gdp_data$REG, levels = c(1, 0),
labels = c("Democracy", "Non-Democracy"))

gdp_data$OIL <- factor(gdp_data$OIL, levels = c(1, 0), labels = c("Exceed 50%", "Otherwise"))

# Fit the multinomial logistic regression model on the data

gdp_data$REG <- relevel(gdp_data$REG, ref = "Non-Democracy")
gdp_data$OIL <- relevel(gdp_data$OIL, ref = "Otherwise")
gdp_data$GDPWdiff_New <- relevel(gdp_data$GDPWdiff_New , ref = "no change")

multinom_model1 <- multinom(GDPWdiff_New ~ REG + OIL + COUNTRY, data = gdp_data)
summary(multinom_model1)
exp(coef(multinom_model1))


```

The results are as follows:

```

  > summary(multinom_model1)
  Call:
  multinom(formula = GDPWdiff_New ~ REG + OIL + COUNTRY, data = gdp_data)

  Coefficients:
           (Intercept) REGDemocracy OILExceed 50%    COUNTRY
  positive    3.015581    0.3550310      8.339428 0.03550780
  negative    2.900080    0.3539634      8.384195 0.02447895

  Std. Errors:
           (Intercept) REGDemocracy OILExceed 50%    COUNTRY
  positive   0.4045963    0.8686107    0.05903403 0.01064706
  negative   0.4056846    0.8702220    0.05903378 0.01066312

```

```
Residual Deviance: 4568.055
AIC: 4584.055
> exp(coef(multinom_model1))
(Intercept) REGDemocracy OILExceed 50%  COUNTRY
positive    20.40094     1.426225      4185.695 1.036146
negative    18.17560     1.424703      4377.332 1.024781
```

Interpretation of coefficients:

Intercept: This is the log odds of no change in GDP, when all predictors are zero. The intercept changes for the shift from no change to positive exp(3) and no change to negative exp(2.9).

REGDemocracy: This is the log odds of GDP change going from no change to positive or no change to negative for a Democracy (1) or a non-Democracy (0).

OILExceed 50 per cent: This is the log odds of GDP change going from no change to positive or no change to negative for a country with fuel exports exceeding 50 per cent (1) or without (0).

Country: log odds representing affects of the country variable.

2. Construct and interpret an ordered multinomial logit with `GDPWdiff` as the outcome variable, including the estimated cutoff points and coefficients.

```r

# ORDERED - PROPORTIONAL ODDS

ordered_model <- polr(GDPWdiff_New ~ REG + OIL + COUNTRY, data = gdp_data, Hess=TRUE)

# Print the summary of the model
summary(ordered_model)

```

The results are as follows:

```

Coefficients:
                 Value     Std. Error  t value
REGDemocracy    0.004128   0.085548   0.04825
OILExceed 50%   0.077470   0.117196   0.66103
COUNTRY        -0.010252   0.001123  -9.13108

```

```
Intercepts:
                     Value    Std. Error  t value
no change|positive  -6.2318   0.2640    -23.6012
positive|negative    0.1769   0.0770      2.2972

Residual Deviance: 4606.003
AIC: 4616.003


```

Interpretation: Both being a democracy and having over 50 per cent oil exports, appear to have a moderate positive affect on GDP change.

Question 2

Consider the data set `MexicoMuniData.csv`, which includes municipal-level information from Mexico. The outcome of interest is the number of times the winning PAN presidential candidate in 2006 (`PAN.visits.06`) visited a district leading up to the 2009 federal elections, which is a count. Our main predictor of interest is whether the district was highly contested, or whether it was not (the PAN or their opponents have electoral security) in the previous federal elections during 2000 (`competitive.district`), which is binary (1=close/swing district, 0="safe seat"). We also include `marginality.06` (a measure of poverty) and `PAN.governor.06` (a dummy for whether the state has a PAN-affiliated governor) as additional control variables.

(a) Run a Poisson regression because the outcome is a count variable. Is there evidence that PAN presidential candidates visit swing districts more? Provide a test statistic and p-value.

```

 # load data
 mexico_elections <- read.csv("https://raw.githubusercontent.com/ASDS-TCD/StatsII_Spring2024/main/datasets/MexicoMuniData.csv")

 # Poisson regression
 mod.ps <- glm(PAN.visits.06 ~ competitive.district + marginality.06 + PAN.governor.06, data = mexico_elections, family = poisson)
 summary(mod.ps)

 # interpreting outputs
 cfs <- coef(mod.ps)
 cfs


```

The results are as follows, with test score and p-values included:

```


Coefficients:
                        Estimate Std. Error z value Pr(>|z|)
(Intercept)             -3.81023    0.22209 -17.156   <2e-16 ***
competitive.district    -0.08135    0.17069  -0.477   0.6336
marginality.06          -2.08014    0.11734 -17.728   <2e-16 ***
PAN.governor.06         -0.31158    0.16673  -1.869   0.0617 .
---
(Dispersion parameter for poisson family taken to be 1)

Null deviance: 1473.87  on 2406  degrees of freedom
Residual deviance:  991.25  on 2403  degrees of freedom
AIC: 1299.2

Number of Fisher Scoring iterations: 7

>
> # interpreting outputs
> cfs <- coef(mod.ps)
> cfs
(Intercept) competitive.district       marginality.06
-3.81023498          -0.08135181          -2.08014361
PAN.governor.06
-0.31157887


```

Is there evidence that PAN presidential candidates visit swing districts more? No, the p-value (0.0617) for PAN governor is not statistically significant at the 0.05 level, and in any case the value for the variable is negative.

(b) Interpret the `marginality.06` and `PAN.governor.06` coefficients.

Interpretation:

For a one unit change in the predictor `marginality.06` coefficient, the difference in the logs of expected counts for the number of times the winning PAN presidential candidate visits is expected to change by -2.08014, given the other predictor variables in the model are held constant.

For a one unit change in the predictor `PAN.governor.06` coefficient, the difference in the logs of expected counts for the number of times the winning PAN presidential candidate visits is expected to change by -0.31158, given the other predictor variables in the model are held constant.

The `marginality.06` coefficient appears to be statistically significant, whereas the `PAN.governor.06` coefficient does not appear to be so.

(c) Provide the estimated mean number of visits from the winning PAN presidential candidate for a hypothetical district that was competitive (`competitive.district`=1), had an average poverty level (`marginality.06` = 0), and a PAN governor (`PAN.governor.06`=1).

$$\lambda = \exp(\beta_0 + \beta_1 \times competitive.district + \beta_2 \times marginality.06 + \beta_3 \times PAN.governor.06)$$
$$\lambda = \exp(\beta_0 + \beta_1 \times 1 + \beta_2 \times 0 + \beta_3 \times 1)$$
$$\lambda = \exp(-3.81023 - 0.08135 \times 1 - 2.08014 \times 0 - 0.31158 \times 1)$$
$$\lambda = \exp(-3.81023 - 0.08135 - 0.31158)$$
$$\lambda = \exp(-4.20316)$$
$$\text{Estimated Mean Visits} = \exp(-4.20316)$$
$$\text{Estimated Mean Visits} \approx 0.015$$