The Effect of Vaccination on Tourism

Sec-8 Team-5

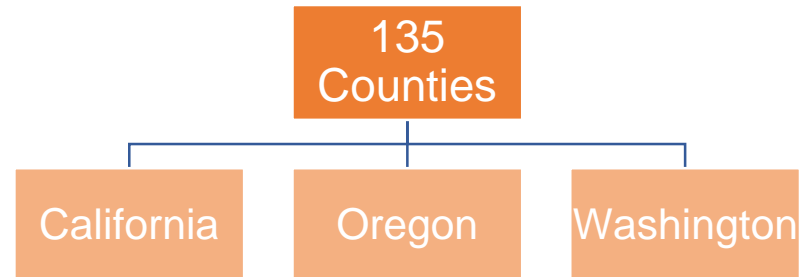Anand Patel, Viswanathan Thiagarajan, Vijay Ranganatha
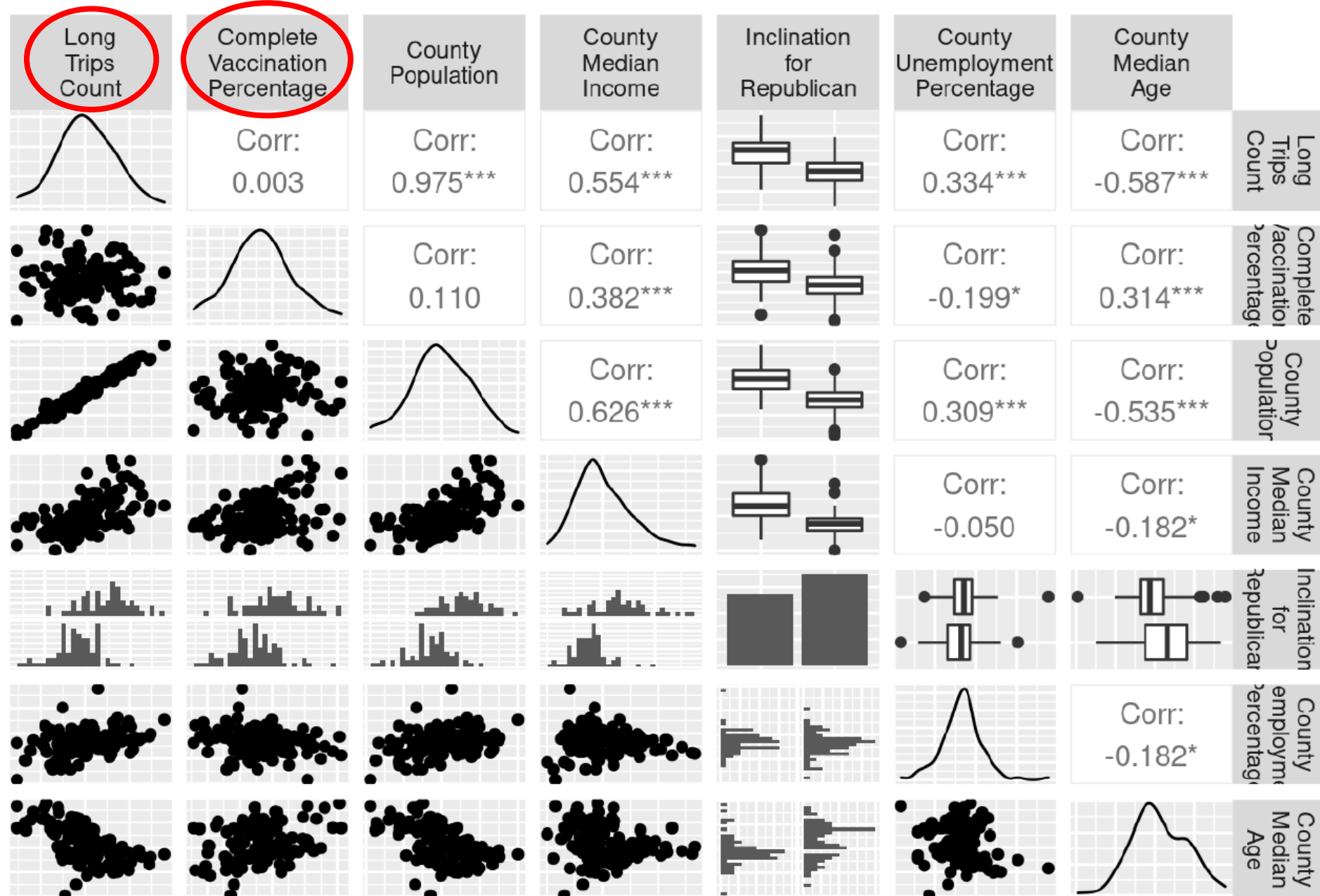
Research

Does having a greater % of vaccinated people, lead to an increase in tourism as represented by more long-distance trips, 50+ miles from home.

- **Audience**
  - **Tourism Board of Continental West Coast States** (California, Oregon, Washington)

135 Counties

California | Oregon | Washington

Log10 Transformed: Plots for Outcome and Features

Final Variable Table

Variable.Name	Variable.Short.Form	Variable.Description
Number.of.Long.Trips_log10	County Level Long Trips Taken (Log10)	Number of 50+ mile trips taken by people from their home. Represents tourism trips.
Series.Complete.Pop.Pct_log10	County Level Vaccination complete percentage (Log10)	Percentage of people who are fully vaccinated.
County.POP_log10	County Population (Log10)	County Population Number.
County.Median.Income_log10	County Median Income (Log10)	Median County Population.
isRepublican	Binary Value 1 for Republican	Indicates Party affiliation of County.
Unemployment.Pct_log10	County Unemployment Percentage (Log10)	County's Unemployment Percentage.
Median.Age_log10	County Median Age (Log10)	County's Median Age.

Models

Limited Model

$$f_1(\text{Long\_Distance\_Trips}) = \beta_0 + \beta_1 f_2(\text{Fully\_Vaccinated\_Pct})$$

Model 2

$$f_1(\text{Long\_Distance\_Trips}) = \beta_0 + \beta_1 f_2(\text{Fully\_Vaccinated\_Pct}) +$$
$$\beta_2 f_3(\text{County\_Population}) + \beta_3 f_4(\text{Median\_Age})$$

All transformations are log10

- Adjusted R2: 0.963
- Standard Error: 0.124
- β1 → **-0.612**
- β2 → 0.822
- Statistically Significant
- A 10% increase in vaccine rate means a 5.6 % reduction in long trips

Model 3

$$f_1(\text{Long\_Distance\_Trips}) = \beta_0 + \beta_1 f_2(\text{Fully\_Vaccinated\_Pct}) +$$
$$\beta_2 f_3(\text{County\_Population}) + \beta_3 f_4(\text{Median\_Age}) +$$
$$\beta_4 \text{isRepublican} + \beta_3 f_5(\text{Median\_County\_Income})$$

All transformations are log10

- Adjusted R2: 0.964
- Standard Error: 0.122
- β1 → **-0.433**
- β2 → 0.861
- Statistically Significant
- A 10% increase in vaccine rate means a 4.2 % reduction in long trips

Regression Table using Robust Standard Errors:

```
##
## =============================================================================
========
##                                    Dependent variable:
##                          ----------------------------------------------------
--------
##                                    Number.of.Long.Trips_log10
##                             (1)              (2)              (3)
## -----------------------------------------------------------------------------
--------
## Series.Complete.Pop.Pct_log10   0.017          -0.612***        -0.433**
##                             (0.680)          (0.162)          (0.183)
##
## County.POP_log10                               0.822***         0.861***
##                                              (0.025)          (0.033)
##
## Median.Age_log10                              -0.419           -0.424
##                                              (0.320)          (0.313)
##
## isRepublican1                                                  0.053
##                                                               (0.036)
##
## County.Median.Income_log10                                    -0.237
##                                                               (0.147)
##
## Constant                     3.994***         1.478**          2.137**
##                             (1.000)          (0.574)          (0.878)
##
## -----------------------------------------------------------------------------
--------
## Observations                   125              125              125
## R2                            0.00001          0.964            0.966
## Adjusted R2                   -0.008           0.963            0.964
## Residual Std. Error      0.648 (df = 123)   0.124 (df = 121)   0.122 (df =
119)
## F Statistic       0.001 (df = 1; 123) 1,076.652*** (df = 3; 121) 669.157*** (df =
5; 119)
## =============================================================================
========
## Note:                                            *p<0.1; **p<0.05; *
**p<0.01
```

- **Negative significant coefficient on Vaccination Rate**
  - <u>People take less tourism trips in counties with high vaccination rates</u>
  - Prior caution and belief in science makes people still hesitant?
  - Even though vaccination rates are high in one county, many destinations might not have high vaccination rates.
  - News of new variants makes vaccinated people who already believe in science hesitant?
- **Not a practically significant coefficient**
  - 10% increase in vaccination rate ⇒ 5.6% reduction in trips taken

- **Positive significant coefficient on Population**
  - more people means more people who can take trips.

CLM & OVM Analysis

IID
- Observations for Continental West Coast States, similar features based on geographic clustering ⇒ not independent
- Mostly share similar Social, Cultural, Economic and Geographical features ⇒ Drawn from Identical Distribution
- Mostly deviate in Population, Median Income Level and counties political leaning
- We add controls to capture differences between counties.

Linear Conditional Exp.
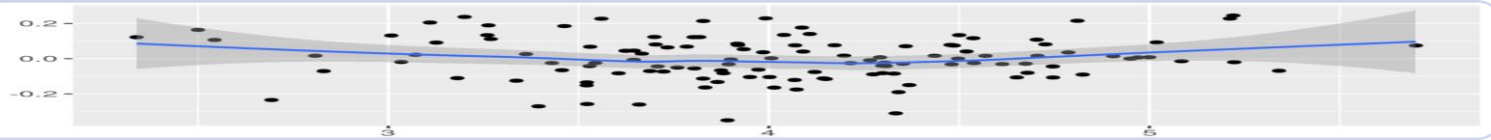
No Multicollinearity
- VIFs are less than 4 for both Models indicating that there is no perfect Multicollinearity

Homoskedastic Var.
- Breush-Pagan Test rejects Null Hypothesis that our error variances are equal (homoskedastic) for our Models
- Must use Robust Standard Errors in reporting

Normally Distributed Errors
- QQ-Norm, Histograms show ~normally distributed residuals for Models 2 & 3
- Shapiro-Wilks Normality test fails to reject the null hypothesis for Models 2 & 3 ⇒ normally distributed residuals

OVM
- Policy of Lifting Mask Req. ⇒ (+)*(+) = (+), beta is (-) ⇒ OV bias towards 0.
- COVID Fatigue ⇒ (+)*(+) = (+), beta is (-) ⇒ OV bias towards 0.
- Vaccine Hesitancy ⇒ (+)*(-) = (-), beta is (-) ⇒ OV bias away from 0.

Conclusion

Exercise Caution Prior to Promoting/Increasing any Expenditure on Tourism

People are not yet feeling comfortable with tourism travel after taking vaccinations

Re-Evaluate Promoting tourism in the future when the vaccination rates are much higher across counties. The COVID-19 climate in the West Coast might be different in the future once all vaccination rates are above a threshold of 80% compared to the current 29.9% average.

Appendix

Running the AIC Test:

Akaike Information Criterion

```
## Start:  AIC=-106.52
## Number.of.Long.Trips_log10 ~ Series.Complete.Pop.Pct_log10
##
##                            Df Sum of Sq    RSS     AIC
## + County.POP_log10          1    49.708  1.926 -515.59
## + Median.Age_log10          1    19.810 31.825 -165.01
## + County.Median.Income_log10 1  18.496 33.139 -159.95
## + isRepublican              1    18.222 33.413 -158.92
## + Unemployment.Pct_log10    1     6.034 45.600 -120.05
## <none>                                  51.635 -106.52
##
## Step:  AIC=-515.59
## Number.of.Long.Trips_log10 ~ Series.Complete.Pop.Pct_log10 +
##       County.POP_log10
##
##                            Df Sum of Sq    RSS     AIC
## + Median.Age_log10          1  0.061865 1.8645 -517.67
## + County.Median.Income_log10 1 0.055888 1.8705 -517.27
## + isRepublican              1  0.045225 1.8811 -516.56
## <none>                                  1.9264 -515.59
## + Unemployment.Pct_log10    1  0.003859 1.9225 -513.84
##
## Step:  AIC=-517.67
## Number.of.Long.Trips_log10 ~ Series.Complete.Pop.Pct_log10 +
##       County.POP_log10 + Median.Age_log10
##
##                            Df Sum of Sq    RSS     AIC
## + isRepublican              1  0.053733 1.8108 -519.32
## + County.Median.Income_log10 1 0.048687 1.8158 -518.97
## <none>                                  1.8645 -517.67
## + Unemployment.Pct_log10    1  0.007764 1.8567 -516.19
##
## Step:  AIC=-519.32
## Number.of.Long.Trips_log10 ~ Series.Complete.Pop.Pct_log10 +
##       County.POP_log10 + Median.Age_log10 + isRepublican
##
##                            Df Sum of Sq    RSS     AIC
## + County.Median.Income_log10 1 0.037326 1.7734 -519.92
## <none>                                  1.8108 -519.32
## + Unemployment.Pct_log10    1  0.008301 1.8025 -517.90
##
## Step:  AIC=-519.92
## Number.of.Long.Trips_log10 ~ Series.Complete.Pop.Pct_log10 +
##       County.POP_log10 + Median.Age_log10 + isRepublican + County.Median.Income_log10
##
##                            Df Sum of Sq    RSS     AIC
## <none>                                  1.7734 -519.92
## + Unemployment.Pct_log10    1 0.0016297 1.7718 -518.04
```
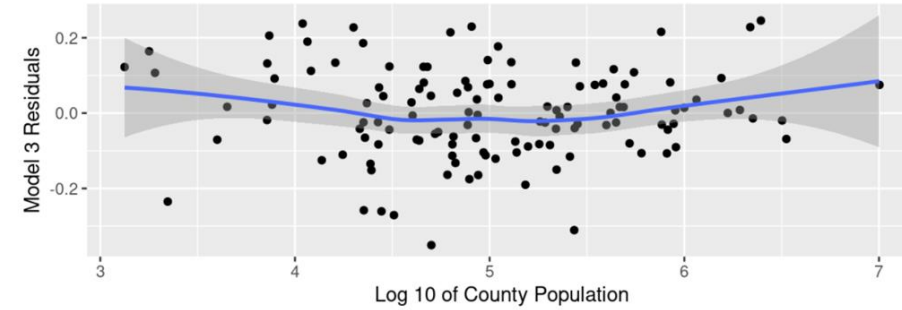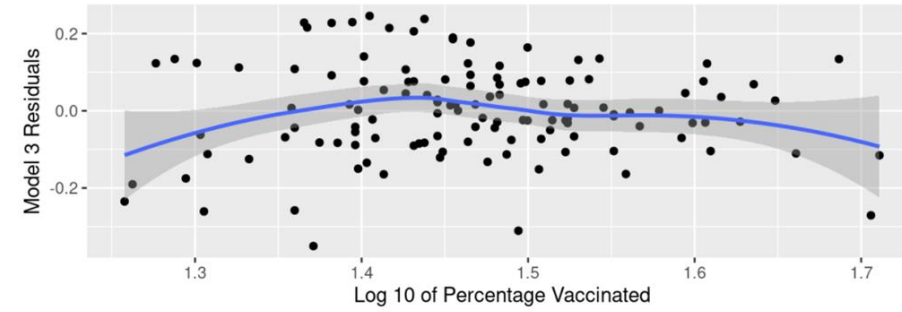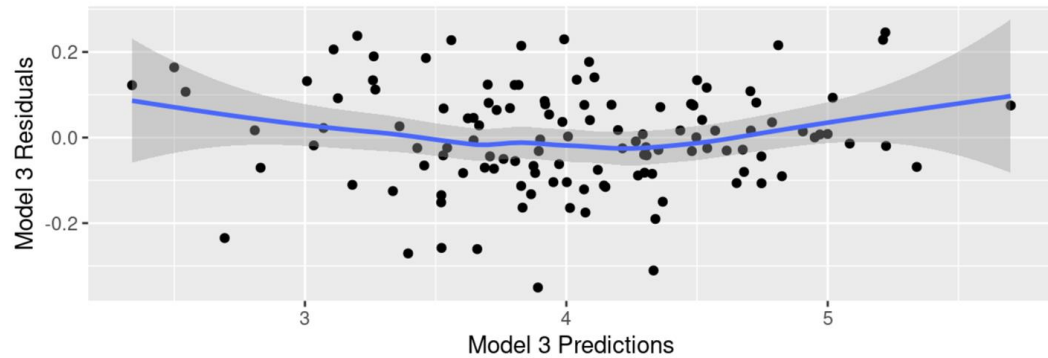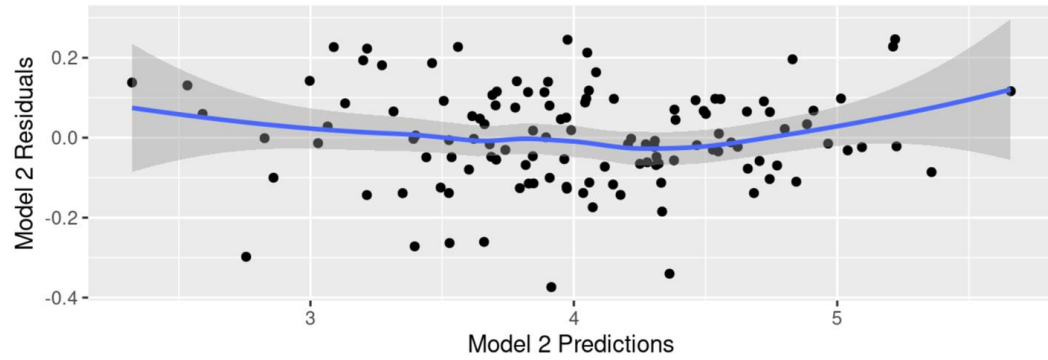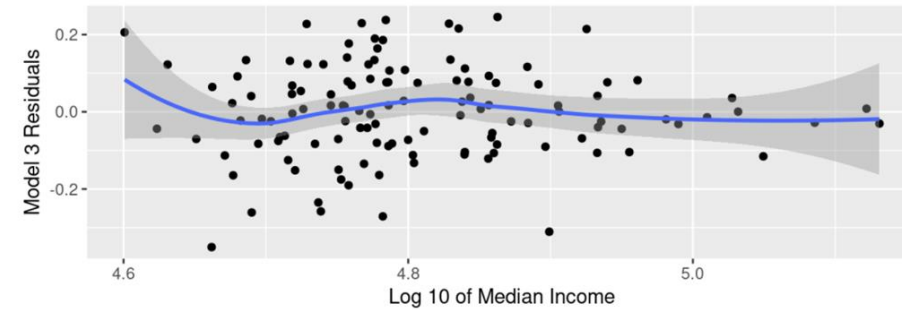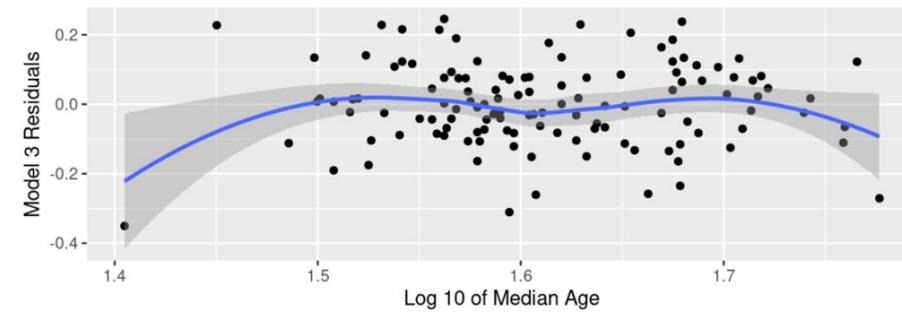
$$f_1(\text{Long\_Distance\_Trips}) = \beta_0 + \beta_1 f_2(\text{Fully\_Vaccinated\_Pct}) + \\ \beta_2 f_3(\text{County\_Population}) + \beta_3 f_4(\text{Median\_Age})$$

Model 2

$$f_1(\text{Long\_Distance\_Trips}) = \beta_0 + \beta_1 f_2(\text{Fully\_Vaccinated\_Pct}) + \\ \beta_2 f_3(\text{County\_Population}) + \beta_3 f_4(\text{Median\_Age}) + \\ \beta_4 \text{isRepublican} + \beta_3 f_5(\text{Median\_County\_Income})$$
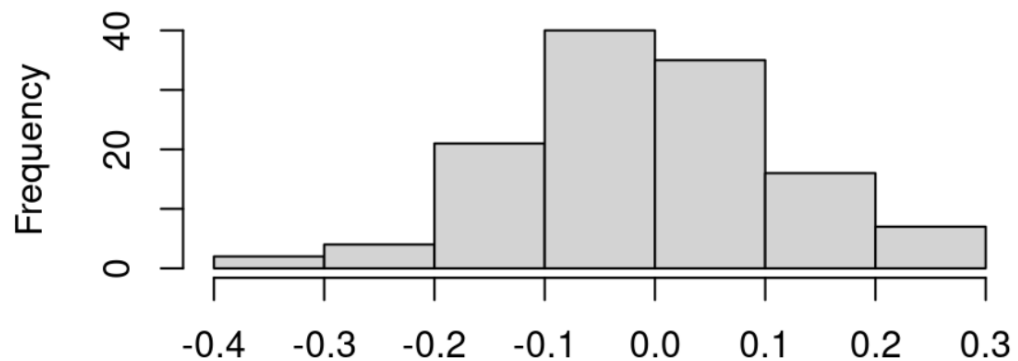
Model 3

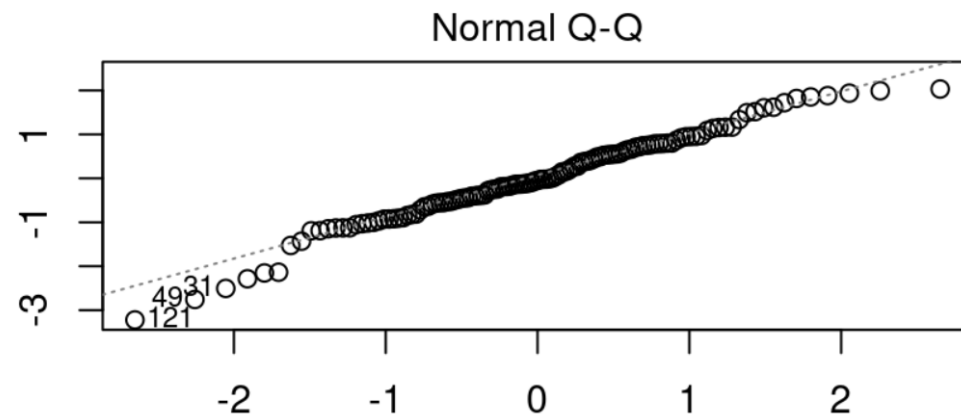CLM 2: Linear Conditional Expectation

Model 2

Frequency
Model 2 Residuals

Residuals Histogram

Normal Q-Q
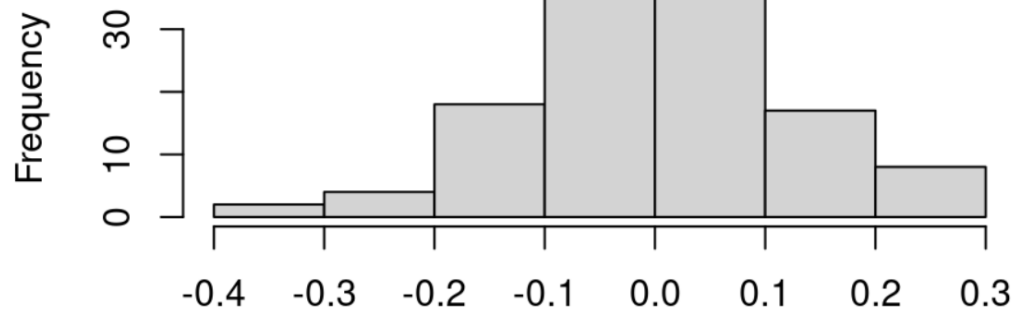
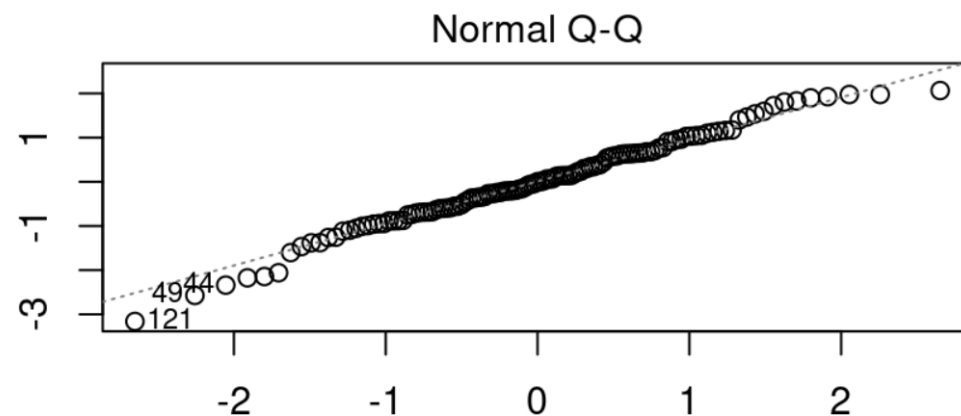Standardized residuals
Model 2 Theoritical Quantities
mber.of.Long.Trips_log10 ~ Series.Complete.Pop.Pct_log10 + Cour

Q-Q Norm plots

Model 3

Frequency
Model 3 Residuals

Normal Q-Q

Standardized residuals
Model 3 Theoritical Quantities
mber.of.Long.Trips_log10 ~ Series.Complete.Pop.Pct_log10 + Cour