Career Choice and Academic Performance

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Overview

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What Do You Want to Be When You Grow Up?

- During high school, young adults are often asked to make decisions regarding post-secondary education that can have a profound and lasting impact on their lives in the future.
- We investigate what factors in high school may be related to future academic performance.

Research Question

- Question: How is college GPA related to prospective career path in high school? How are other characteristics about a student’s background and high school environment related to their college GPA?
- This study aims to investigate whether students who have a desired future career path in the 9th grade perform better than students who do not, and if choice of career path matters.

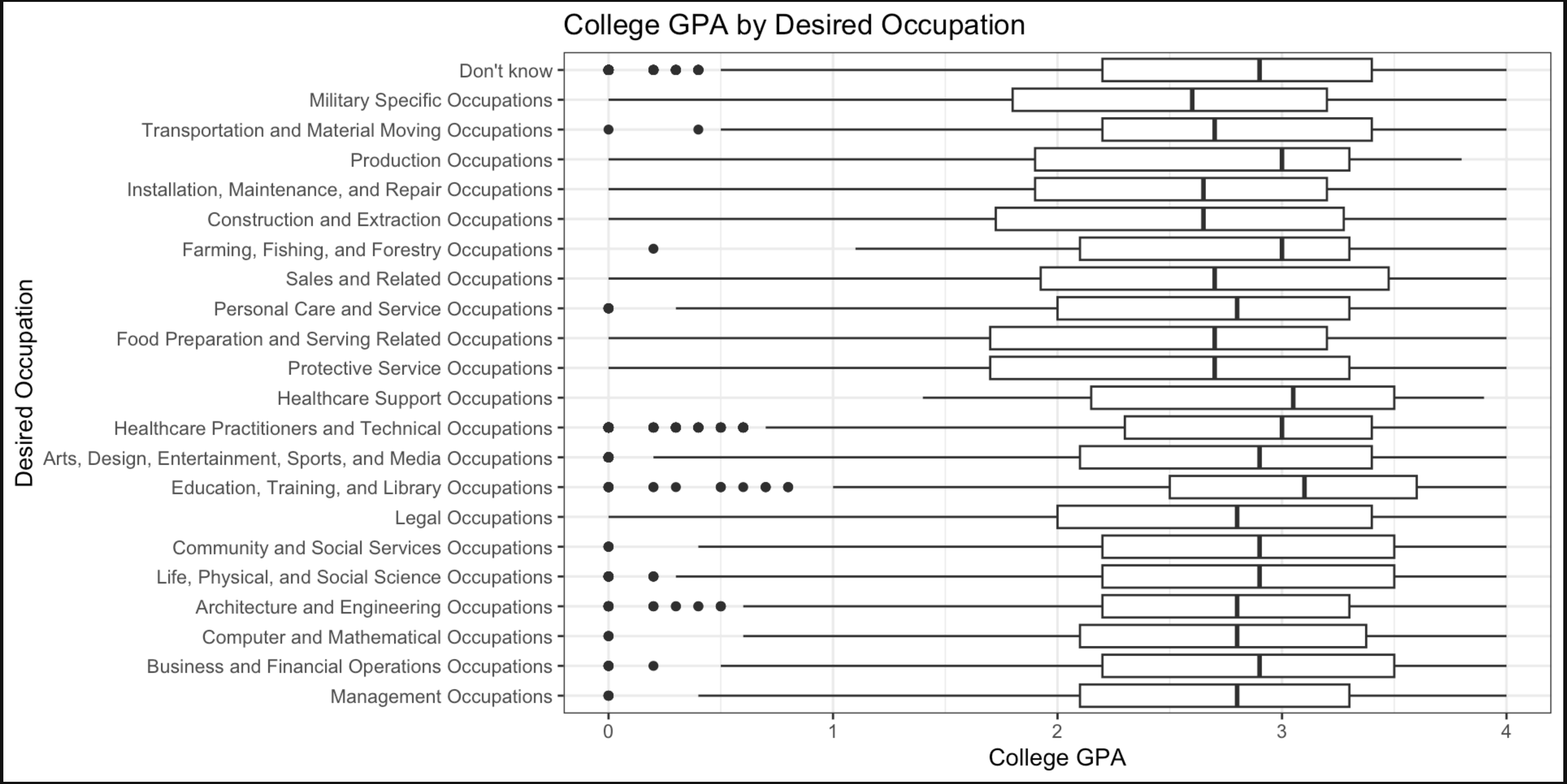
Data

- High School Longitudinal Study of 2009 (HSLS:09) from the National Center for Education Statistics.
    - Interviewed 9th graders across the United States in 2009.
    - Followed up with subjects in three subsequent interview rounds.
    - Offers a variety of information on students, parents, and school.

Key Variables

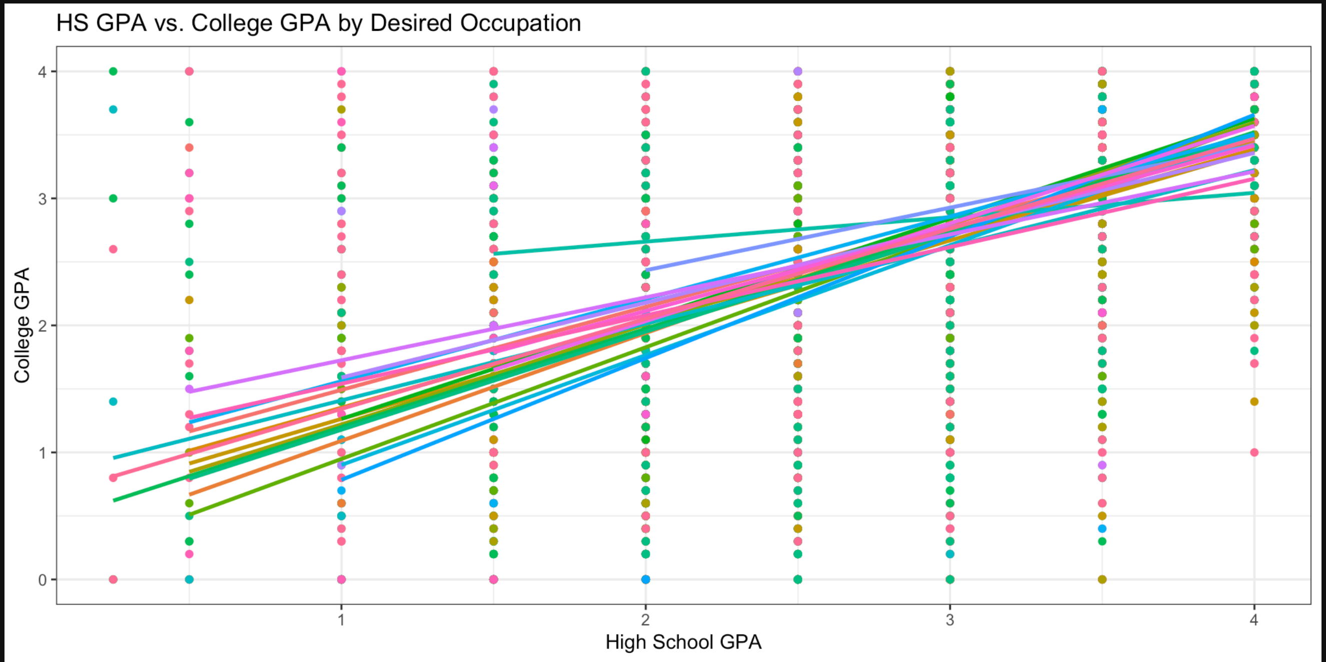
- Response Variable: College GPA
- Primary Predictor of Interest: Desired occupation at age 30.
    - A categorical variable with 22 occupation groups.
- Additional predictors:
    - Academic: High school GPA, credits earned for AP/IB courses, School engagement, Stem/non-stem desired occupation
    - Geographic and Socioeconomic Factors: Family Income, High School urbanicity, High School type

A Look at Desired Occupation



Desired Occupation and Academic Performance

Color-coded by Planned student occupation at age 30



```
            College_GPA    HS_GPA
College_GPA   1.0000000 0.5630064
HS_GPA        0.5630064 1.0000000
```

Model: Simple Linear Regression

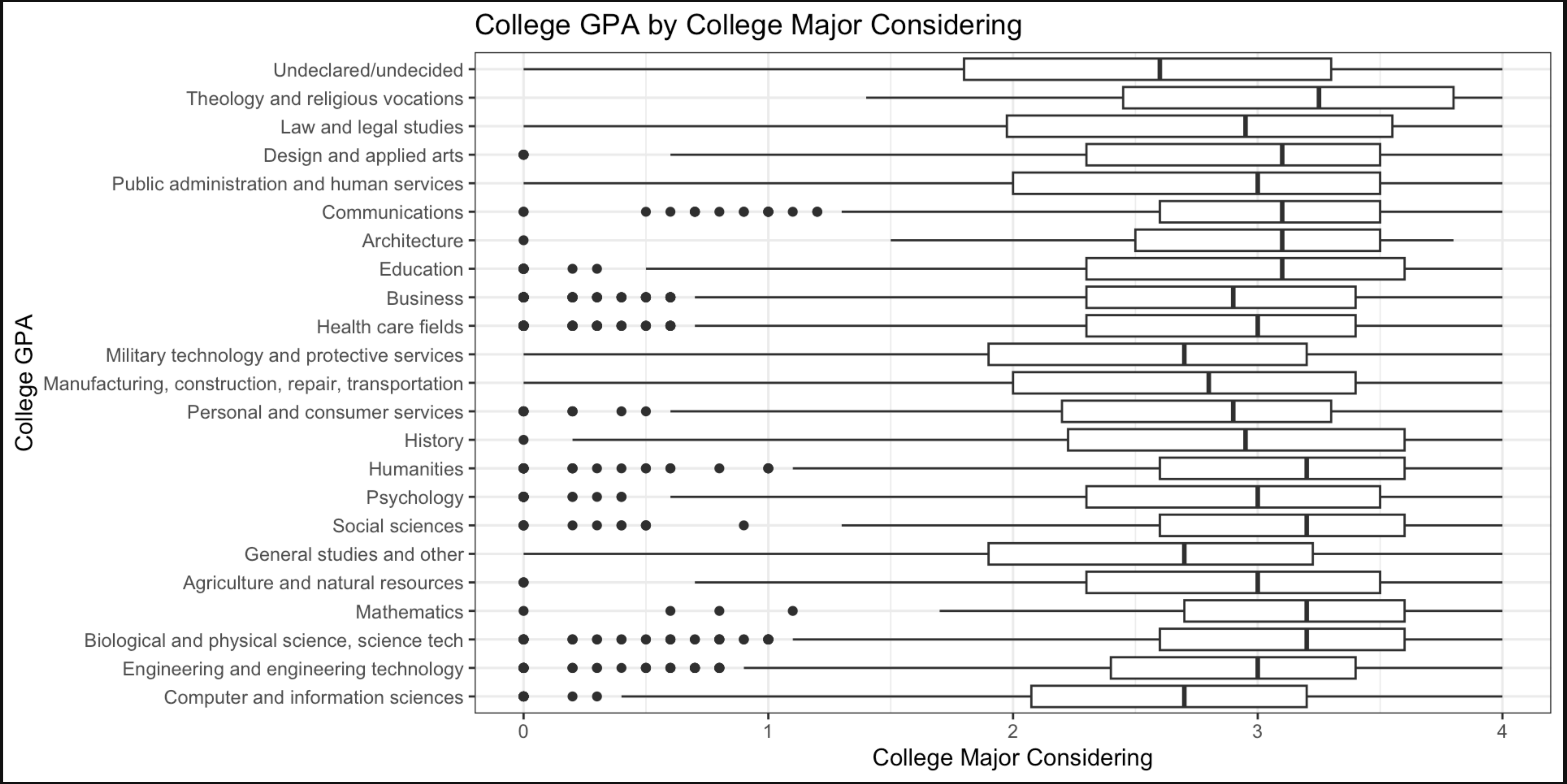
- Set reference group to those students who answered “Don’t Know”.
- Model takes the form of $\mathrm{College\_GPA} = \beta_0 + \beta_1 \mathrm{future\_job} + \epsilon$.

Results: Simple Linear Regression

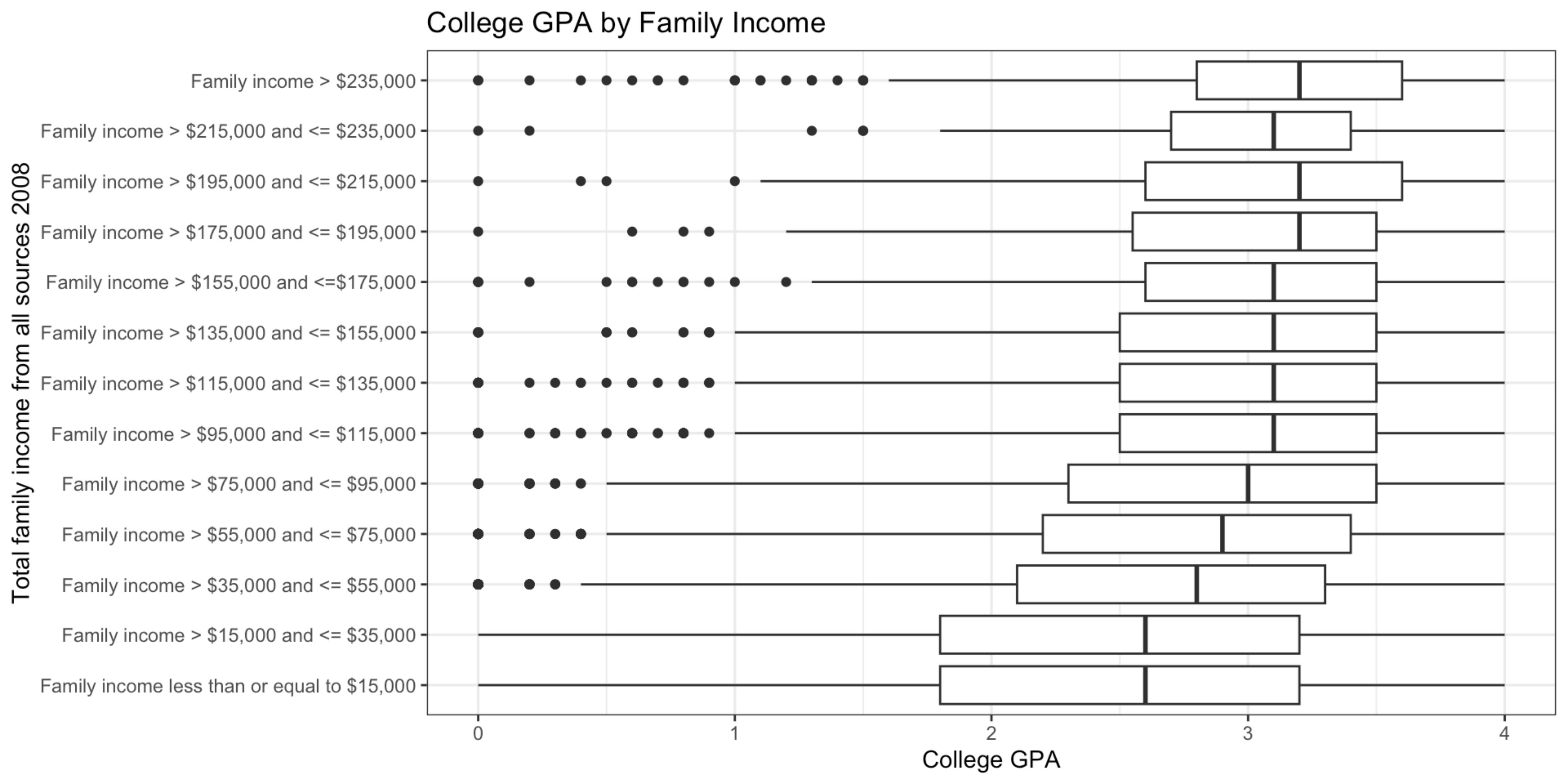
- Showing only results with a p-value < 0.10.

```
# A tibble: 7 × 5
  term                                      estimate std.error statistic
p.value
  <chr>                                        <dbl>     <dbl>     <dbl>
<dbl>
1 (Intercept)                                  2.72     0.0170    160.   0
2 Education, Training, and Library Occupat…    0.192    0.0454      4.24
2.28e-5
3 Arts, Design, Entertainment, Sports, and…   -0.109    0.0303     -3.60
3.16e-4
4 Protective Service Occupations              -0.317    0.0595     -5.33
1.00e-7
5 Food Preparation and Serving Related Occ…   -0.329    0.0878     -3.75
1.79e-4
6 Installation, Maintenance, and Repair Oc…   -0.271    0.104      -2.62
8.84e-3
```

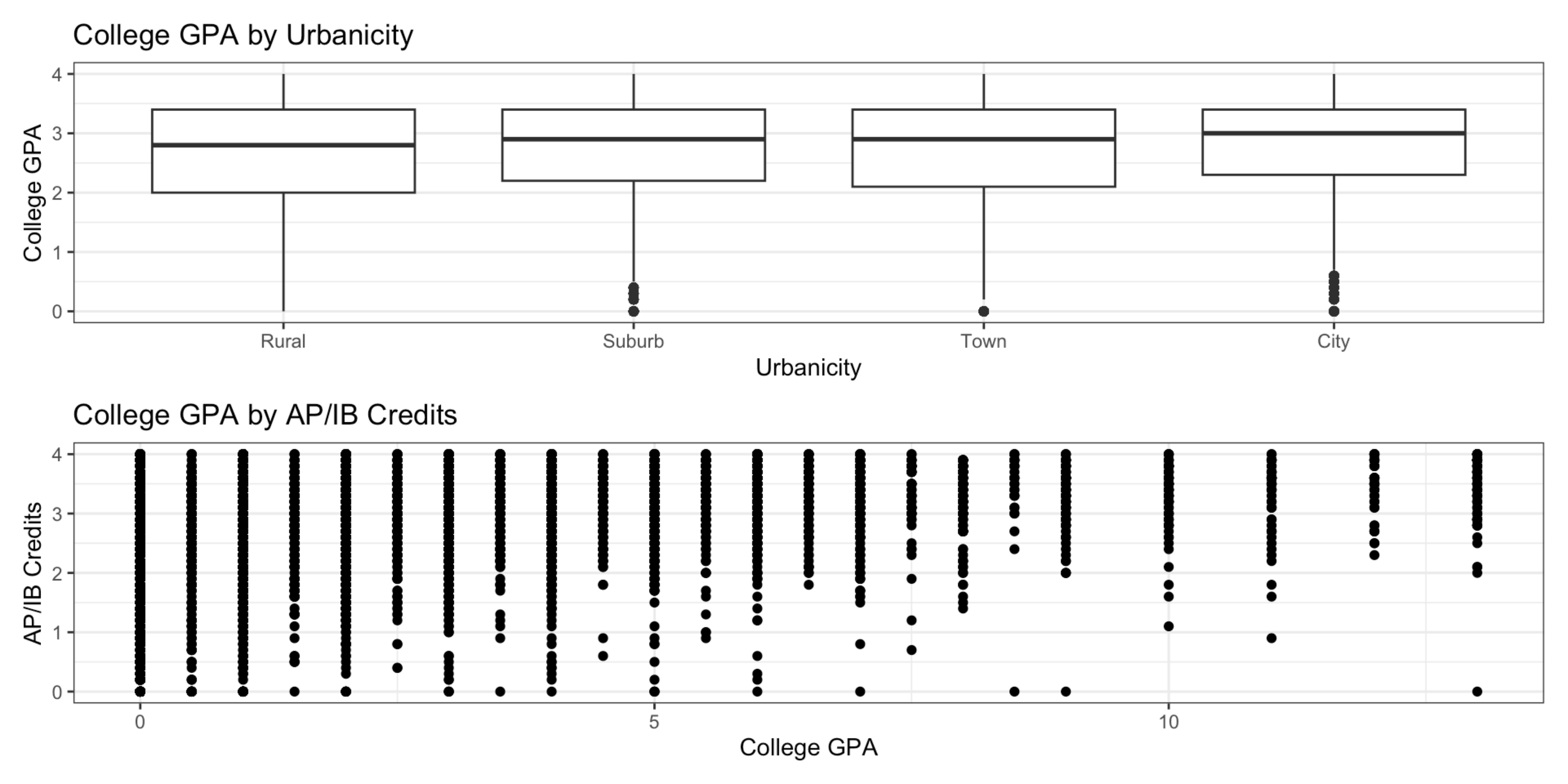
Additional Variables



Additional Variables



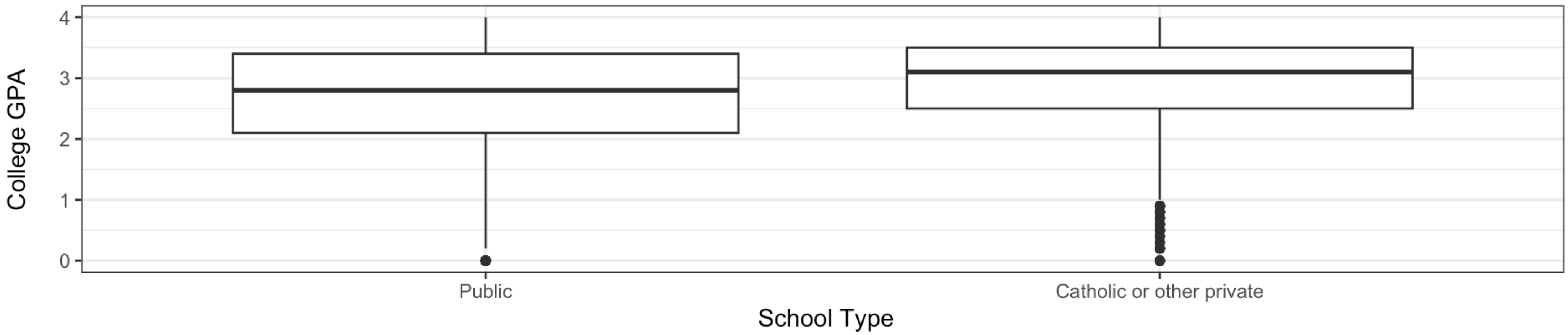
Additional Variables

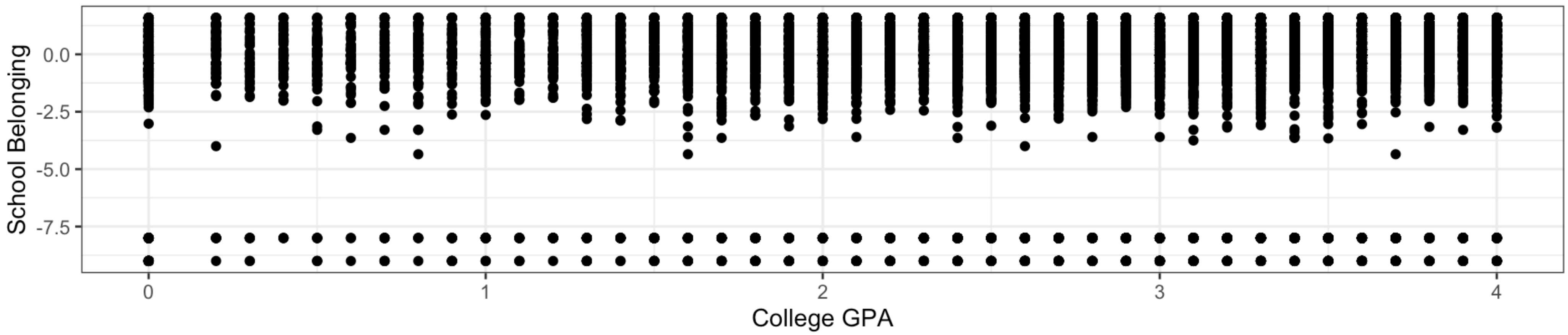


College GPA by Urbanicity

College GPA by AP/IB Credits

Additional Variables


College GPA by School Type


College GPA by Student’s Sense of School Belonging

Multiple Linear Regression

Initial MLR Model:

$$\text{College\_GPA} = \beta_0 + \beta_1\, \text{future\_job} + \beta_2\, \text{college\_gpa} + \beta_3\, \text{major\_considering} + \beta_4\, \text{family\_income} + \beta_5\, \text{credits} + \beta_6\, \text{school\_type} + \beta_7\, \text{urbanicity} + \beta_8\, \text{school\_belonging} + \epsilon$$

- Adjusted R^2: 0.3563
- F-statistic: 66.59 on 62 and 7286 DF, p-value: < 2.2e-16

Remove Urbanicity & School Belonging?

- Urbanicity & School Belonging: All Betas are insignificant at alpha = 0.10

Lack of Fit Test

- Null Hypothesis: $\beta_7 \text{urbanicity} = \beta_8 \text{school\_belonging} = 0$
- Alternative hypothesis: either of the betas for these variables is a non-zero value
- Use alpha = 0.10

Remove Urbanicity & School Belonging?

```
Analysis of Variance Table

Model 1: X5GPAALL ~ X1STU30OCC2 + X3TGPAACAD + X4ENTRYMAJ23 + X1FAMINCOME + 
    X3TCREDAPIB + X1CONTROL
Model 2: X5GPAALL ~ X1STU30OCC2 + X3TGPAACAD + X4ENTRYMAJ23 + X1LOCALE + 
    X1FAMINCOME + X3TCREDAPIB + X1CONTROL + X1SCHOOLBEL
  Res.Df    RSS Df Sum of Sq    F Pr(>F)
1   7290 3608.0                         
2   7286 3605.7  4    2.2764 1.15  0.331
```

- With a P-value of 0.331, there is insufficient evidence to reject the null hypothesis that the values for the betas of these two predictors are not zero.
- The lack of significant relationship between Urbanicity & School Belonging was seen in earlier plots.

Variable Selection

New MLR Model:

$$\text{College\_GPA} = \\ \beta_0 + \beta_1 \, future\_job + \beta_2 \, college\_gpa + \beta_3 \, major\_considering + \\ \beta_4 \, family\_income + \beta_5 \, credits + \beta_6 \, school\_type + \epsilon$$

- Stepwise selection did not remove additional variables

Diagnostics

Linearity

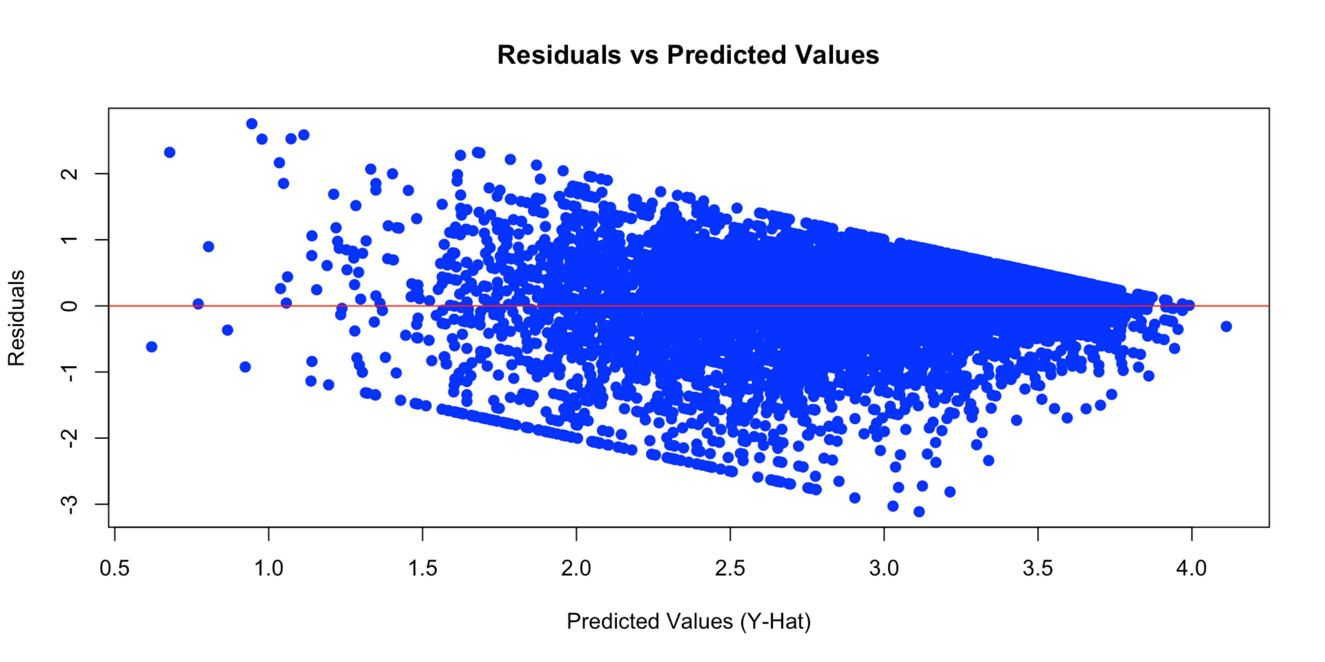
- F-statistic: 71.1 on 58 and 7290 DF, p-value: < 2.2e-16

```
Call:
lm(formula = X5GPAALL ~ X1STU30OCC2 + X3TGPAACAD + X4ENTRYMAJ23 +
    X1FAMINCOME + X3TCREDAPIB + X1CONTROL, data = MLR_all)

Residuals:
     Min       1Q   Median       3Q      Max
-3.11365 -0.34477  0.09234  0.43827  2.75491

Coefficients:

Estimate
(Intercept)
0.4541565
X1STU30OCC2Management Occupations
0.0153304
```

Diagnostics

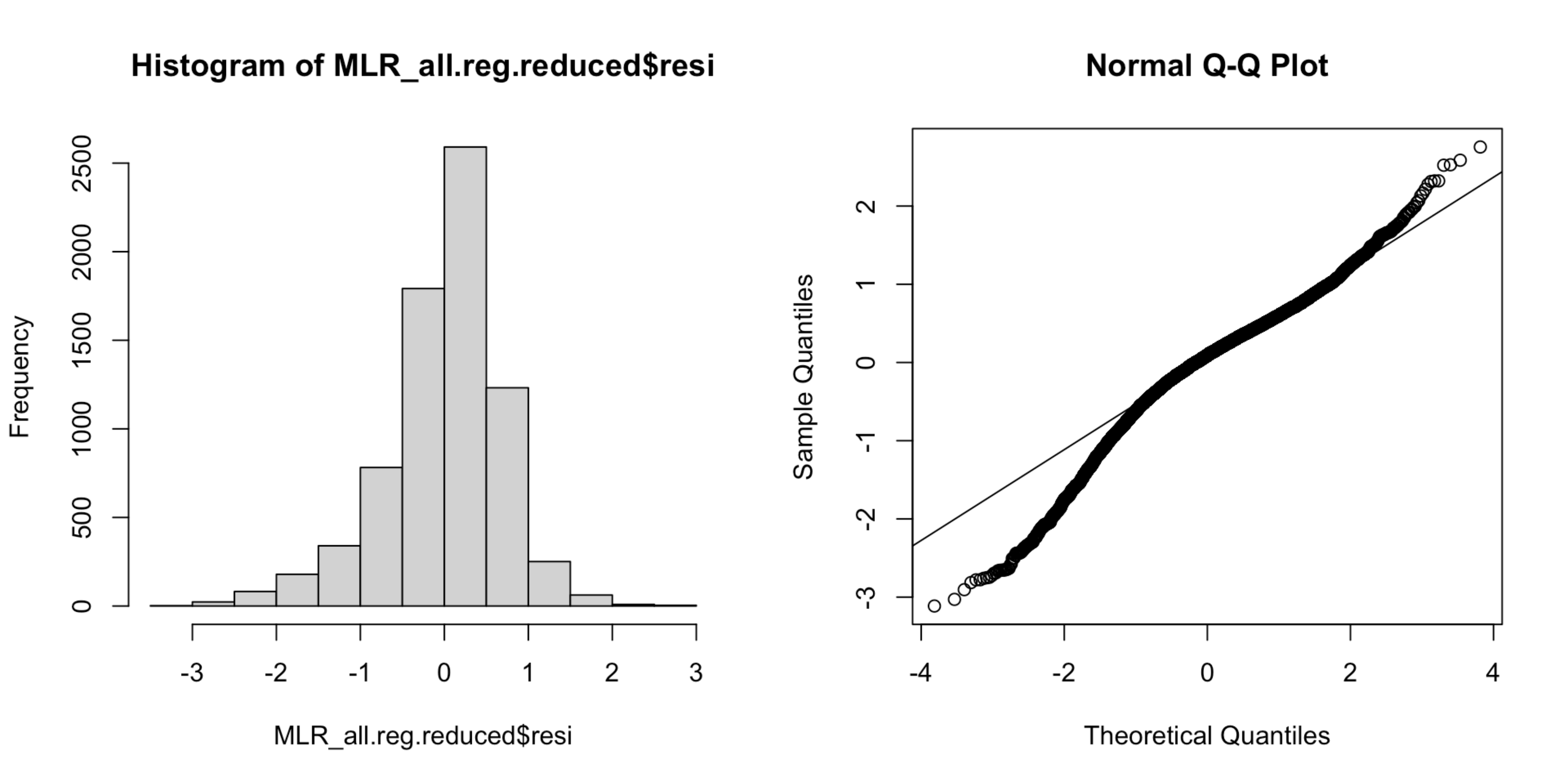
Constant Variance

- Breusch-Pagan test yields a p-value < 0.0001.
- Because the response variable is bound.



Diagnostics

Normality



Remedial Measures

- Need to address non-constant variance first, and then recheck normality assumption
- Try Box-Cox transformation
- Weighted Least Squares
- Recheck model diagnostics.

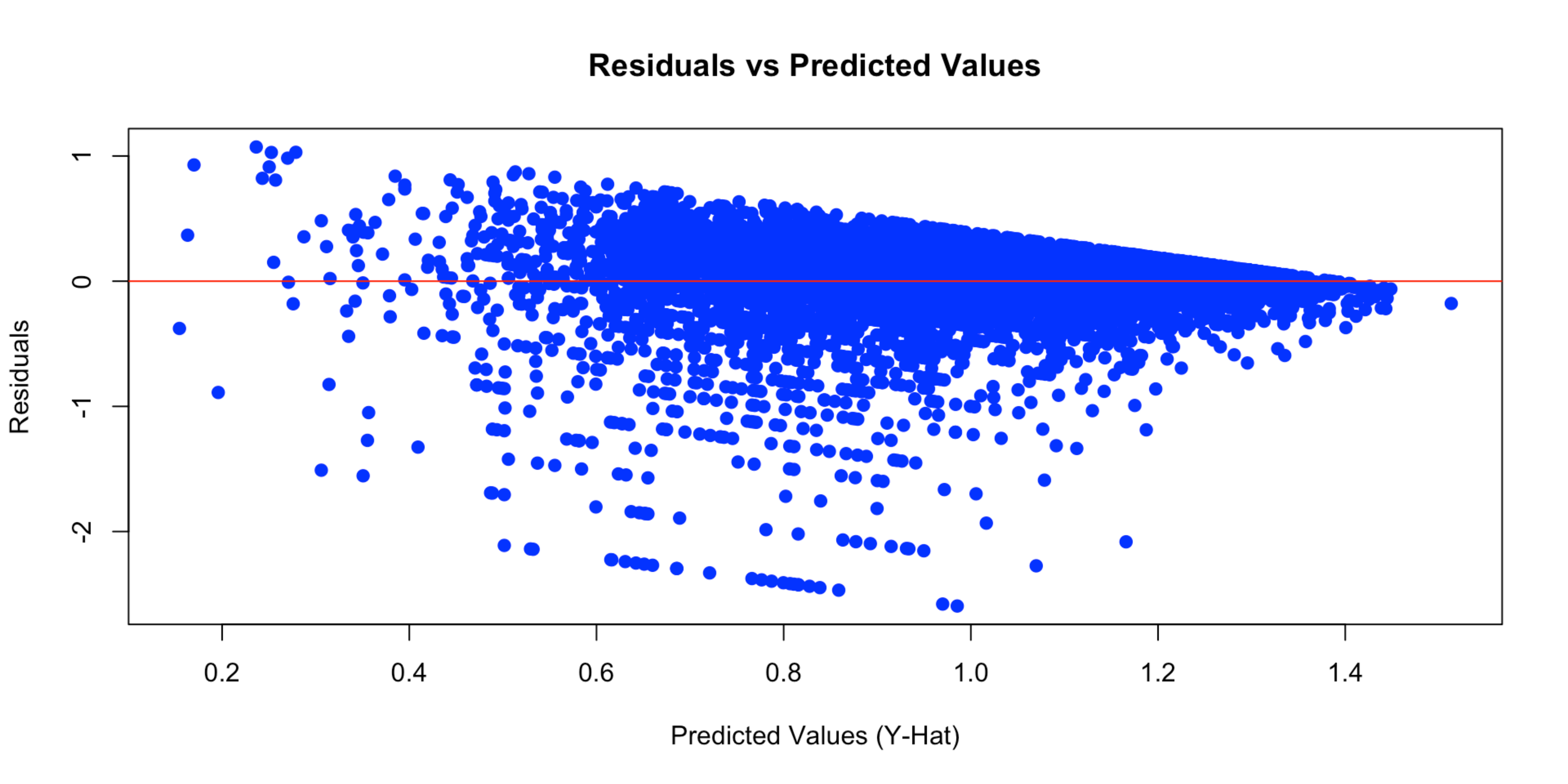
Try Box-Cox Transformation

Need to get rid of all 0.0 GPAs

```
Call:
lm(formula = log(X5GPAALL) ~ X1STU30OCC2 + X3TGPAACAD + X4ENTRYMAJ23 +
    X1FAMINCOME + X3TCREDAPIB + X1CONTROL, data = MLR_all_no_0)

Coefficients:
                                                          (Intercept)
                                                            0.0109720
                                    X1STU30OCC2Management Occupations
                                                            0.0093697
             X1STU30OCC2Business and Financial Operations Occupations
                                                            0.0510748
                     X1STU30OCC2Computer and Mathematical Occupations
                                                           -0.0217388
                  X1STU30OCC2Architecture and Engineering Occupations
                                                            0.0244767
```

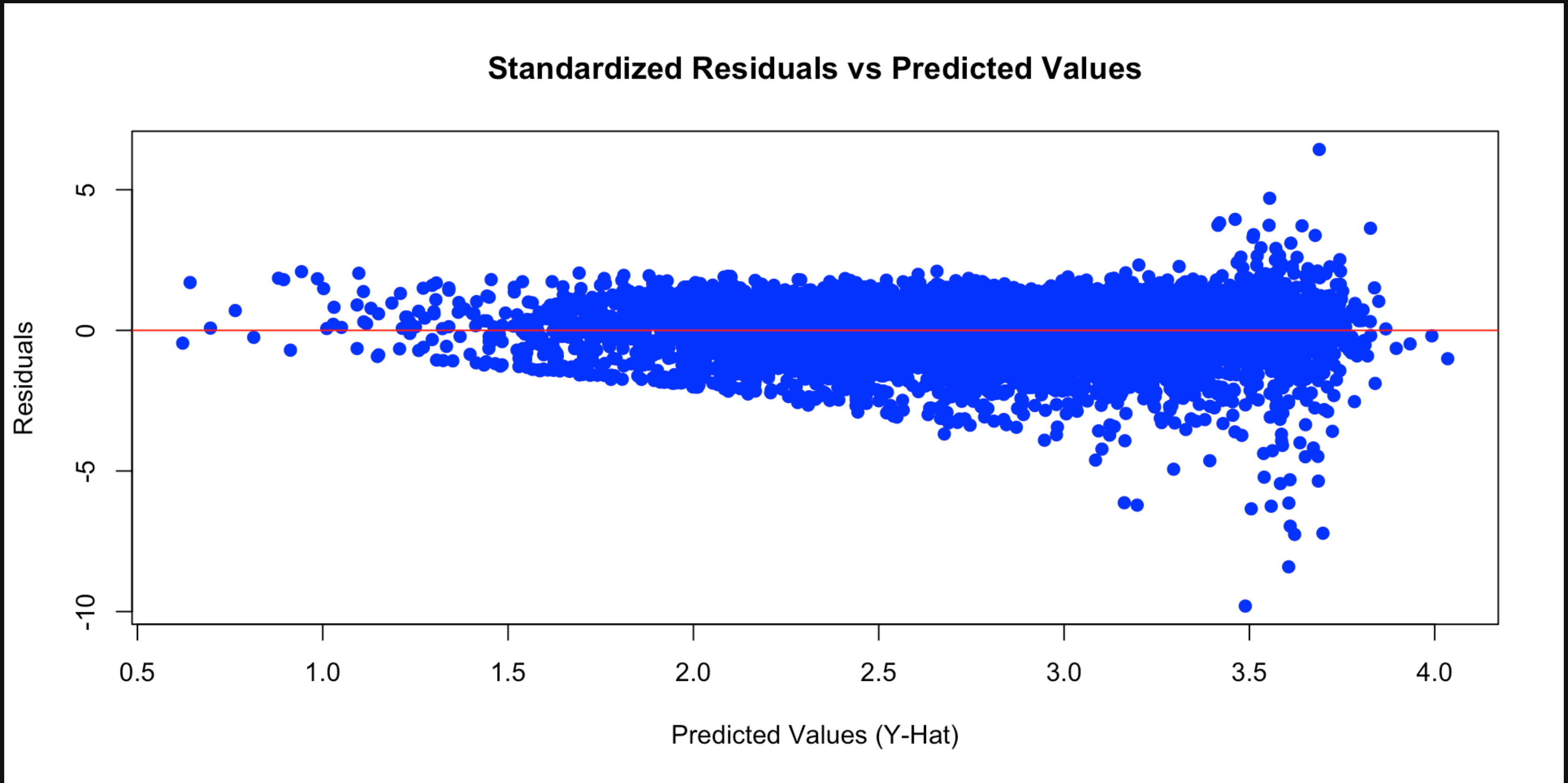
Box-Cox Residual Variance

Still a pattern



Weighted Least Squares on Full Model

Can’t reach coefficient convergence.

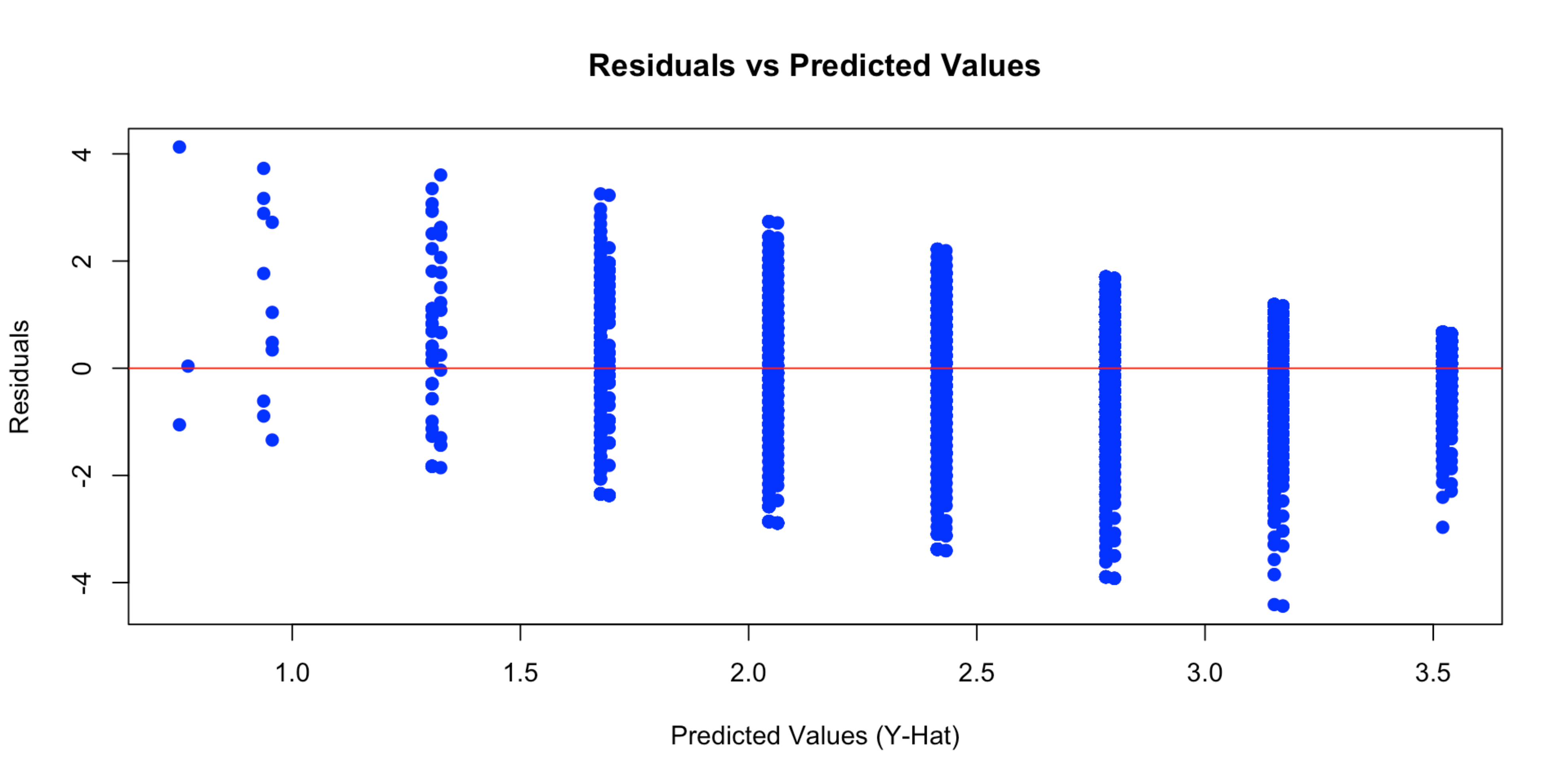


Make Predictor “Don’t Know” vs. “Know” Future Occupation

```
Call:
lm(formula = X5GPAALL ~ career + X3TGPAACAD, data = MLR_all)

Residuals:
    Min      1Q  Median      3Q     Max 
-3.1704 -0.3517  0.1174  0.4483  2.9471 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  0.58715    0.04001   14.67   <2e-16 ***
career      -0.01878    0.01859   -1.01    0.313    
X3TGPAACAD   0.73808    0.01212   60.92   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

0-1 Career Residual Variance

Still a pattern.



Implications & Limitations

- Non-constant variance could not be addressed through transformation and other remedies given this set of predictors
- Perhaps other predictors not captured by the High School Longitudinal Study are more reliably related to College GPA and choice of future career
- Additionally, other regression approaches, such as Quantile regression, may be useful for exploring the significance of this relationship