

# Generalized Estimating Equations

Test name: Generalized Estimating Equations

Dataset: D:/DATA ANALYSIS/H Regression Tests and Models/Generalized Estimating Equations/dataset.csv

Rows in original dataset: 649

Columns in original dataset: 33

Complete subject clusters used: 649

Repeated observations used: 1947

Repeated score variables: G1, G2, G3

Numeric predictors: studytime, failures, absences, age, Medu, Fedu

Categorical predictors: school, sex, address

Formula:  $\text{gee\_score} \sim \text{grade\_time} + \text{studytime} + \text{failures} + \text{absences} + \text{age} + \text{Medu} + \text{Fedu} + \text{school} + \text{sex} + \text{address}$

Family/link: Gaussian identity.

Cluster variable: subject\_id.

Working correlations fitted: independence and exchangeable.

Exchangeable working rho: 0.8096

Independence quasi-information: 3640.0248

Exchangeable quasi-information: 3640.0248

Exchangeable working correlation has the lower quasi-information value.

Interpretation: coefficients are marginal population-average effects on the repeated score outcome.

Decision guide:  $p < 0.05$  indicates stronger evidence for a predictor effect after robust sandwich correction.

Reporting guide: state cluster id, repeated outcome, working correlation, marginal coefficients, robust SEs, p-values, and fit comparison.

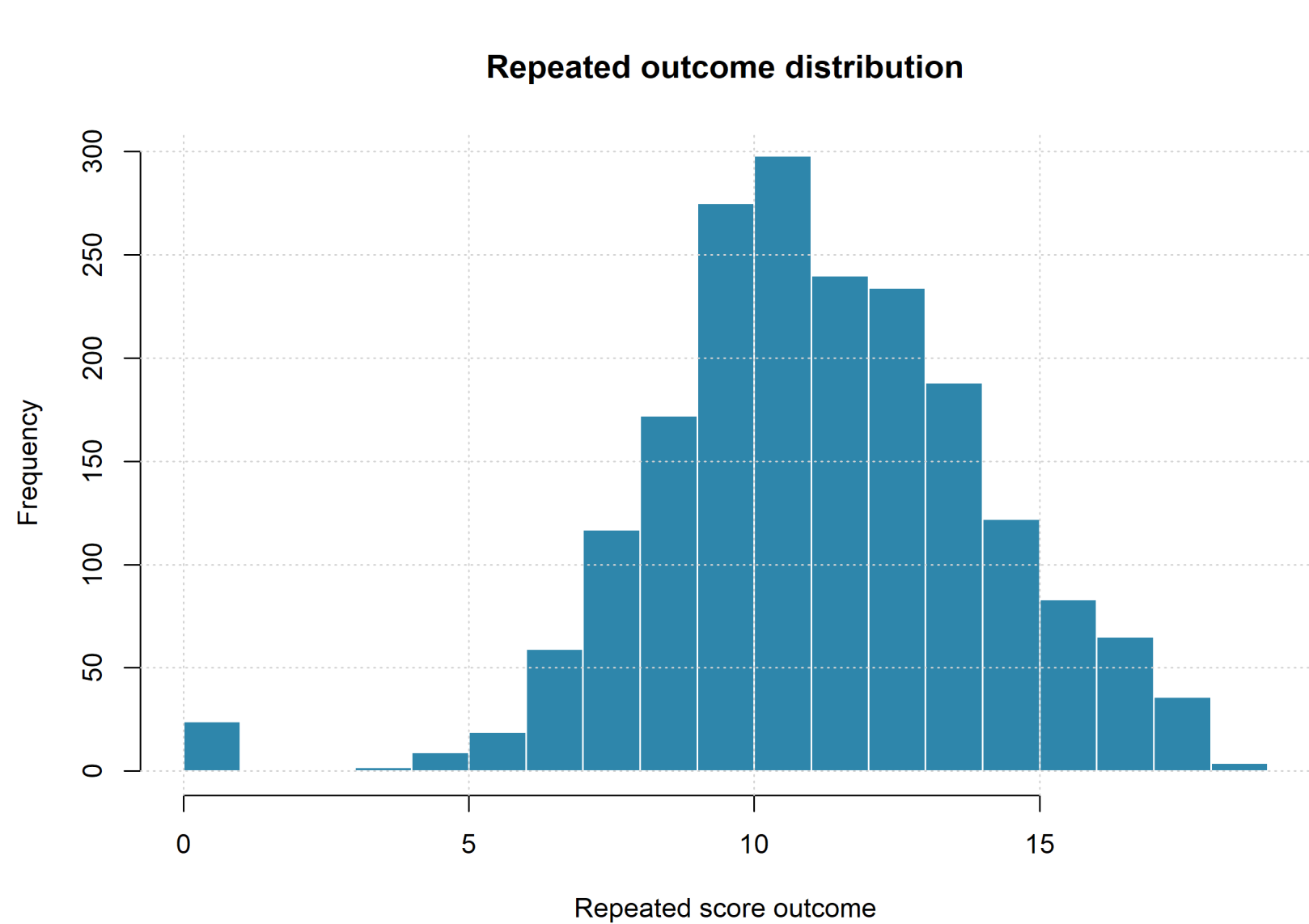
Charts generated: 8

# GEE exchangeable coefficients

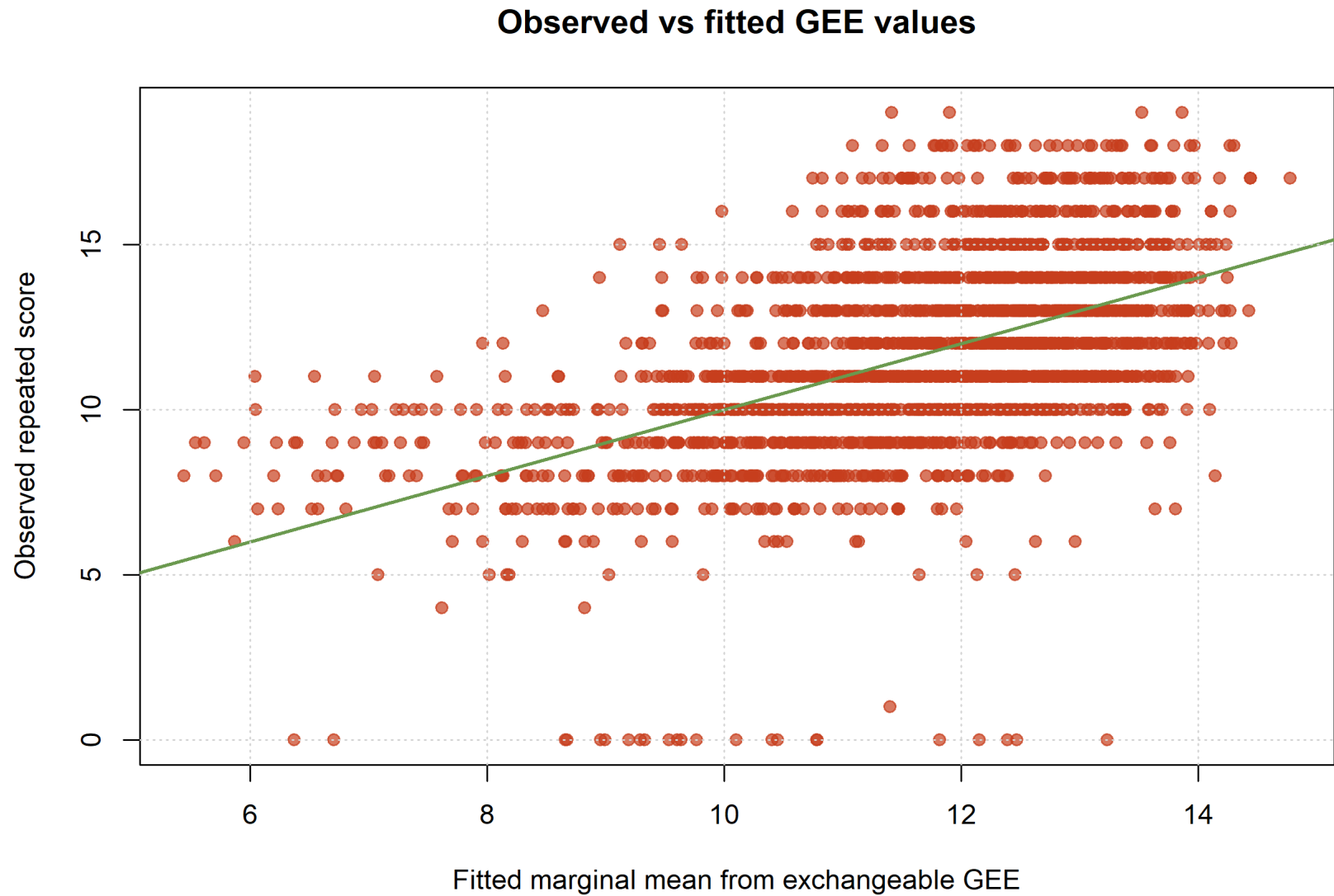
|                                               | model        | term         | marginal_coefficient | robust_standard_error         |
|-----------------------------------------------|--------------|--------------|----------------------|-------------------------------|
| Gaussian GEE exchangeable working correlation | (Intercept)  |              | 9.98379760           | 1.39421632                    |
| Gaussian GEE exchangeable working correlation | grade_time.L |              | 0.35845629           | 0.05049863                    |
| Gaussian GEE exchangeable working correlation | grade_time.Q |              | 0.06730750           | 0.03331761                    |
| Gaussian GEE exchangeable working correlation | studytime    |              | 0.46399983           | 0.11970010                    |
| Gaussian GEE exchangeable working correlation | failures     |              | -1.50474071          | 0.16124346                    |
| Gaussian GEE exchangeable working correlation | absences     |              | -0.06713066          | 0.02168703                    |
| Gaussian GEE exchangeable working correlation | age          |              | 0.04507471           | 0.08078096                    |
| Gaussian GEE exchangeable working correlation | Medu         |              | 0.27319605           | 0.11789089                    |
| Gaussian GEE exchangeable working correlation | Fedu         |              | 0.15763297           | 0.11588021                    |
| Gaussian GEE exchangeable working correlation | schoolMS     |              | -1.25792539          | 0.24210384                    |
| Gaussian GEE exchangeable working correlation | sexM         |              | -0.58003305          | 0.19795041                    |
| Gaussian GEE exchangeable working correlation | addressU     |              | 0.28059464           | 0.23535524                    |
| wald_chi_square                               | p_value      | ci95_lower   | ci95_upper           | decision_alpha_0_05           |
| 51.2780155                                    | 8.016843e-13 | 7.251183821  | 12.71641139          | Statistically significant     |
| 50.3863946                                    | 1.262666e-12 | 0.259480800  | 0.45743178           | Statistically significant     |
| 4.0811176                                     | 4.336497e-02 | 0.002006174  | 0.13260882           | Statistically significant     |
| 15.0261109                                    | 1.060339e-04 | 0.229391938  | 0.69860772           | Statistically significant     |
| 87.0881592                                    | 1.037901e-20 | -1.820772086 | -1.18870933          | Statistically significant     |
| 9.5816783                                     | 1.965287e-03 | -0.109636460 | -0.02462486          | Statistically significant     |
| 0.3113493                                     | 5.768534e-01 | -0.113253061 | 0.20340248           | Not statistically significant |
| 5.3701741                                     | 2.048393e-02 | 0.042134159  | 0.50425795           | Statistically significant     |
| 1.8504424                                     | 1.737319e-01 | -0.069488066 | 0.38475400           | Not statistically significant |
| 26.9964337                                    | 2.038312e-07 | -1.732440202 | -0.78341057          | Statistically significant     |
| 8.5860353                                     | 3.387507e-03 | -0.968008719 | -0.19205738          | Statistically significant     |
| 1.4213826                                     | 2.331760e-01 | -0.180693155 | 0.74188244           | Not statistically significant |

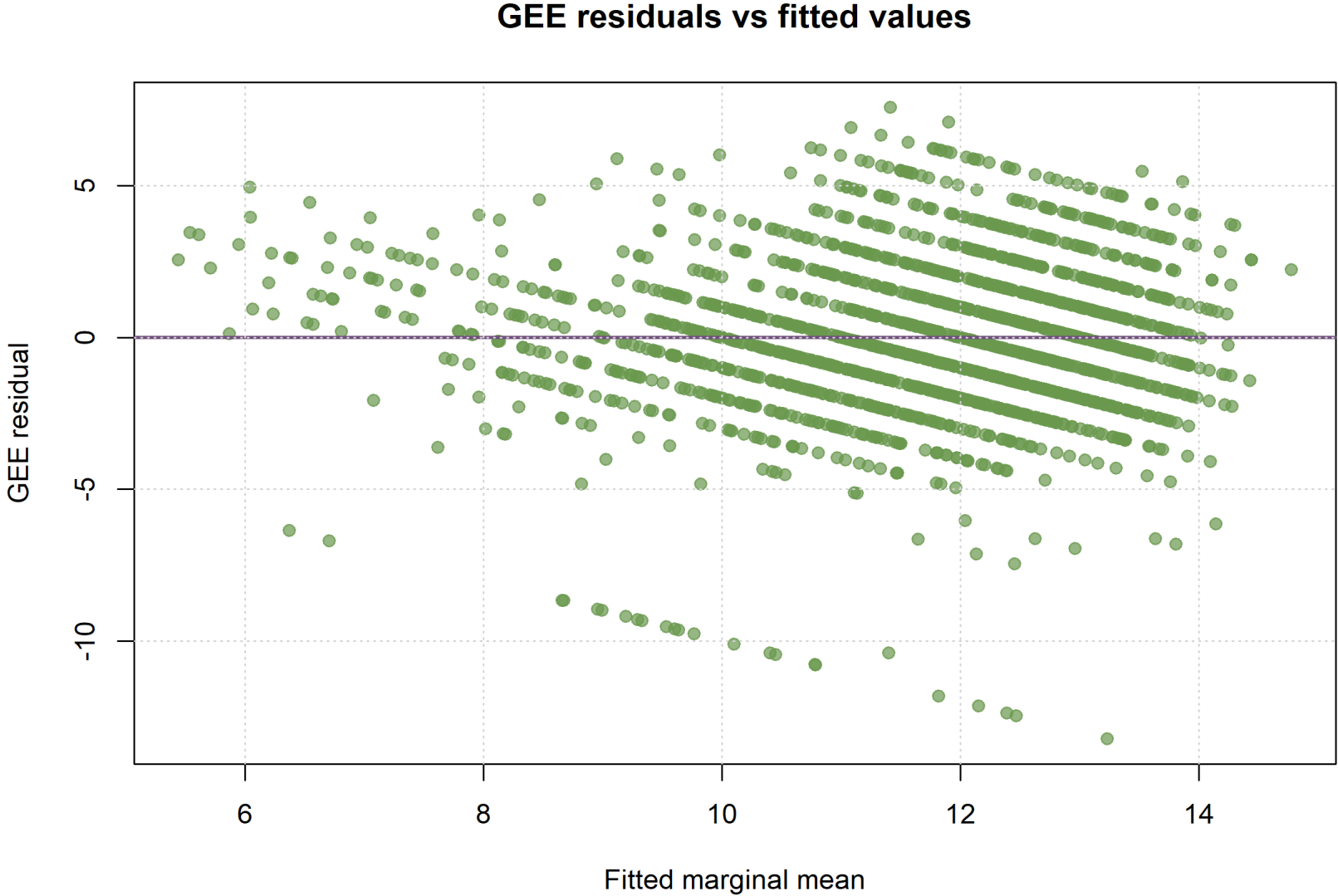
# GEE fit statistics

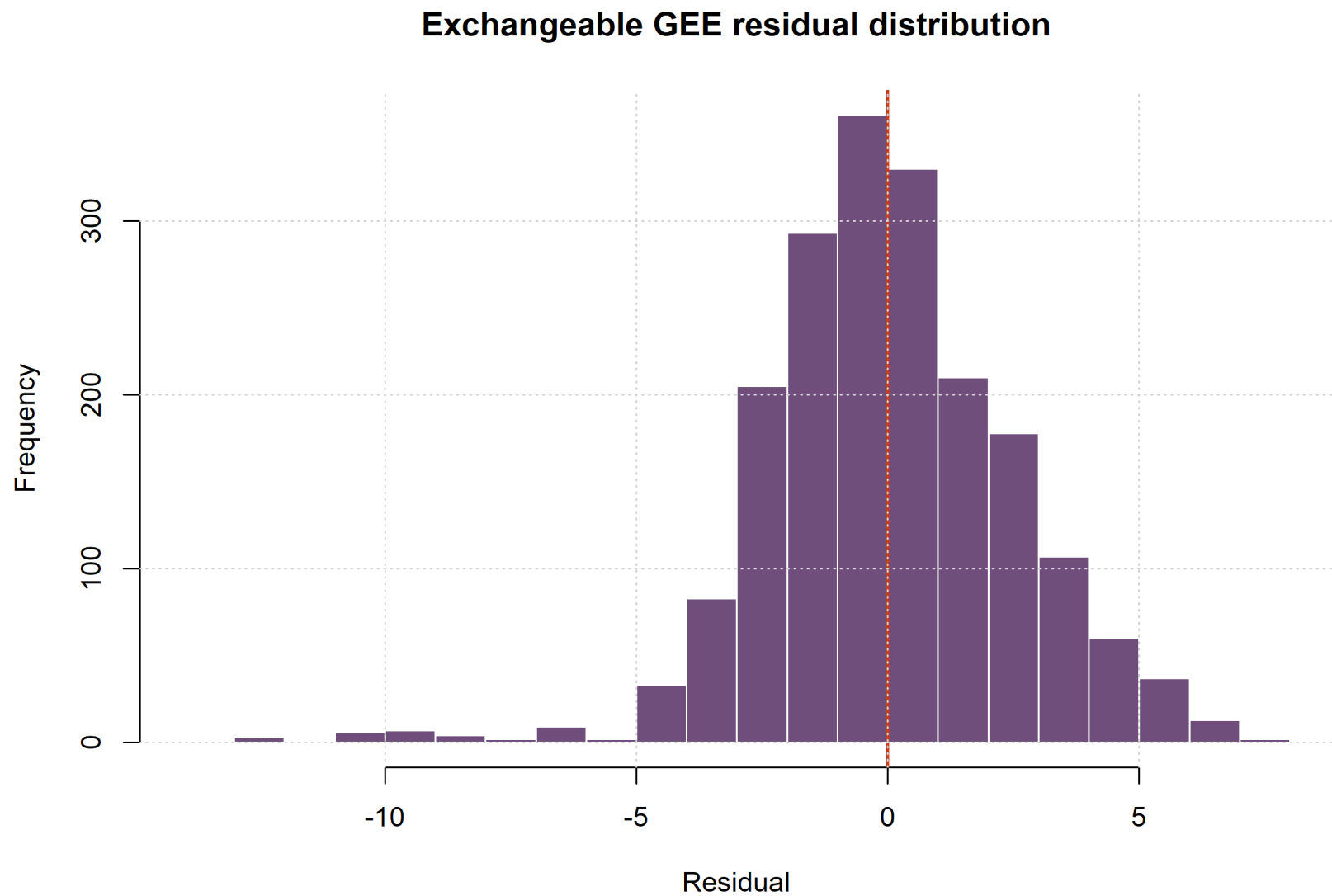
|            | model                                                                               | family                | link                | working_correlation | n_repeated_observations |                                   |
|------------|-------------------------------------------------------------------------------------|-----------------------|---------------------|---------------------|-------------------------|-----------------------------------|
|            | Gaussian GEE                                                                        | independence          | working correlation | Gaussian identity   | independence            | 1947                              |
|            | Gaussian GEE                                                                        | exchangeable          | working correlation | Gaussian identity   | exchangeable            | 1947                              |
| n_clusters | parameters                                                                          | estimated_working_rho | scale_parameter     | rmse                | mae                     | quasi_information_lower_is_better |
| 649        | 12                                                                                  | 0.0000000             | 6.445688            | 2.531               | 1.901495                | 3640.025                          |
| 649        | 12                                                                                  | 0.8095698             | 6.445688            | 2.531               | 1.901495                | 3640.025                          |
| converged  |                                                                                     |                       |                     |                     |                         | note                              |
|            | TRUE Base-R Gaussian GEE estimating equations with robust sandwich standard errors. |                       |                     |                     |                         |                                   |
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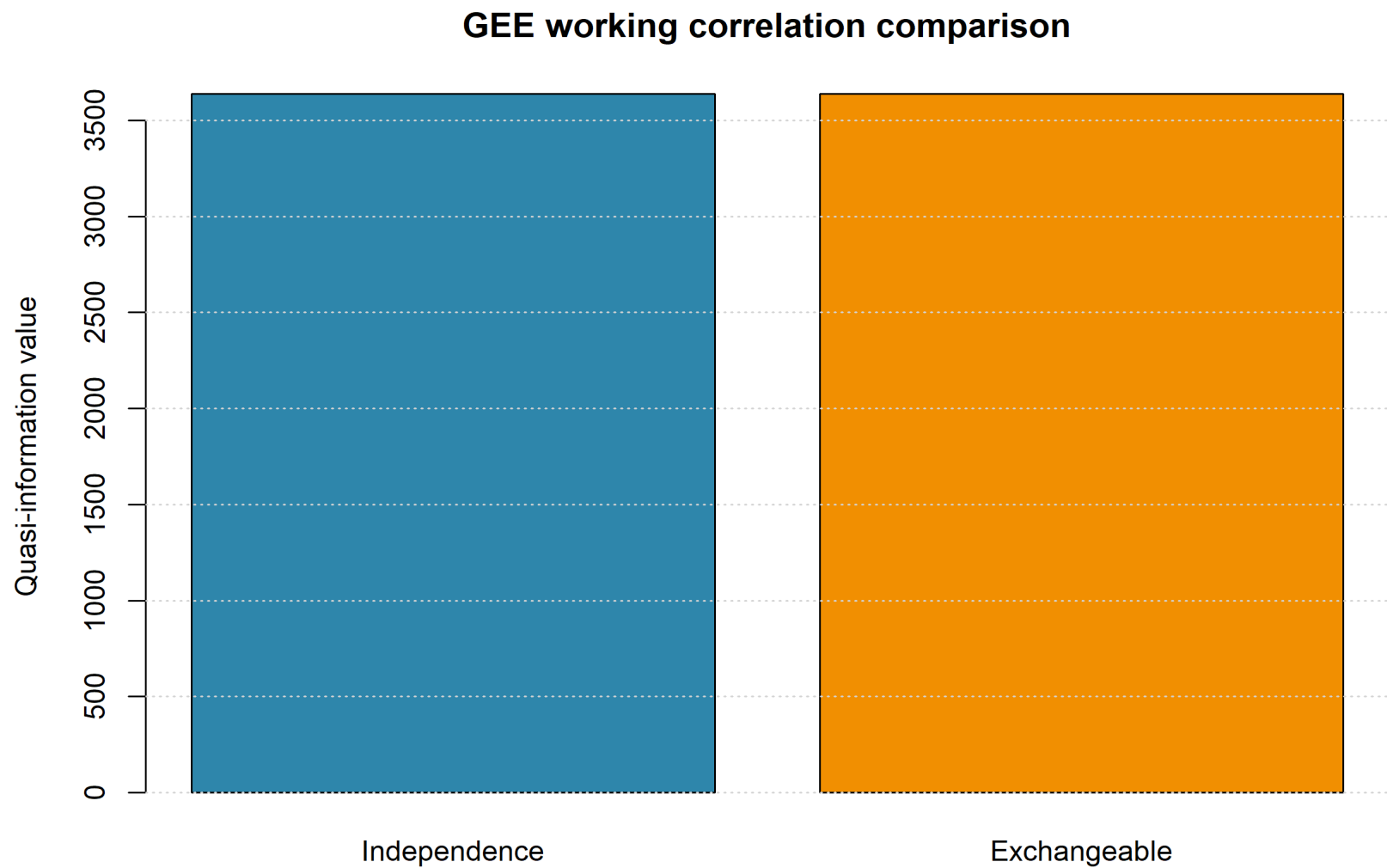












Exchangeable GEE marginal coefficient plot

