Hierarchical Regression

Test name: Hierarchical Regression

Dataset: D:/DATA ANALYSIS/H Regression Tests and Models/Hierarchical Regression/dataset.csv

Rows in original dataset: 649

Columns in original dataset: 33

Rows used in hierarchical models: 649

Outcome variable: G3

Number of fitted blocks: 3

Final model predictors excluding intercept: 28

Final R squared: 0.8563

Final adjusted R squared: 0.8498

Final model F statistic: 131.9304

Final model p−value: 4.71181e−240

Largest R squared change block: Block 2 = 0.7297

Final RMSE: 1.2238

Final MAE: 0.77

Interpretation: hierarchical regression evaluates whether each added block explains extra variance beyond previous blocks.

Decision guide: a significant F−change p−value indicates that a block adds statistically meaningful explanatory power.

Reporting guide: report block order, R square, adjusted R square, R square change, F−change, p−value, and final coefficients.

Charts generated: 8

Hierarchical regression model fit and R−square change

block	model	n	predictor_count_excluding_intercept	r_squared	adjusted_r_squared	r_squared_change	f_statistic	model_p_value	f_change	f_change_df1	f_change_df2	f_change_p_value	aic	bic	rmse	mae
1	Block 1 − Background and demographics	649	6	0.1226654	0.1144660	0.122665425	14.96031	4.664467e−16	NA	6	642	NA	3293.994	3329.798	3.023699	2.2508150
2	Block 2 − Prior achievement and academic variables	649	11	0.8523817	0.8498326	0.729716300	334.38035	4.187606e−256	629.7720032	5	637	9.704528e−244	2147.308	2205.489	1.240298	0.7793849
3	Block 3 − Family, support, and behavioral variables	649	28	0.8562836	0.8497931	0.003901828	131.93037	4.711808e−240	0.9901578	17	620	4.674330e−01	2163.923	2298.186	1.223796	0.7699838

purpose
Controls for student background before academic predictors are added.
Tests whether achievement and study variables improve prediction after background controls.
Tests whether additional family, support, and behavior variables explain extra variance.

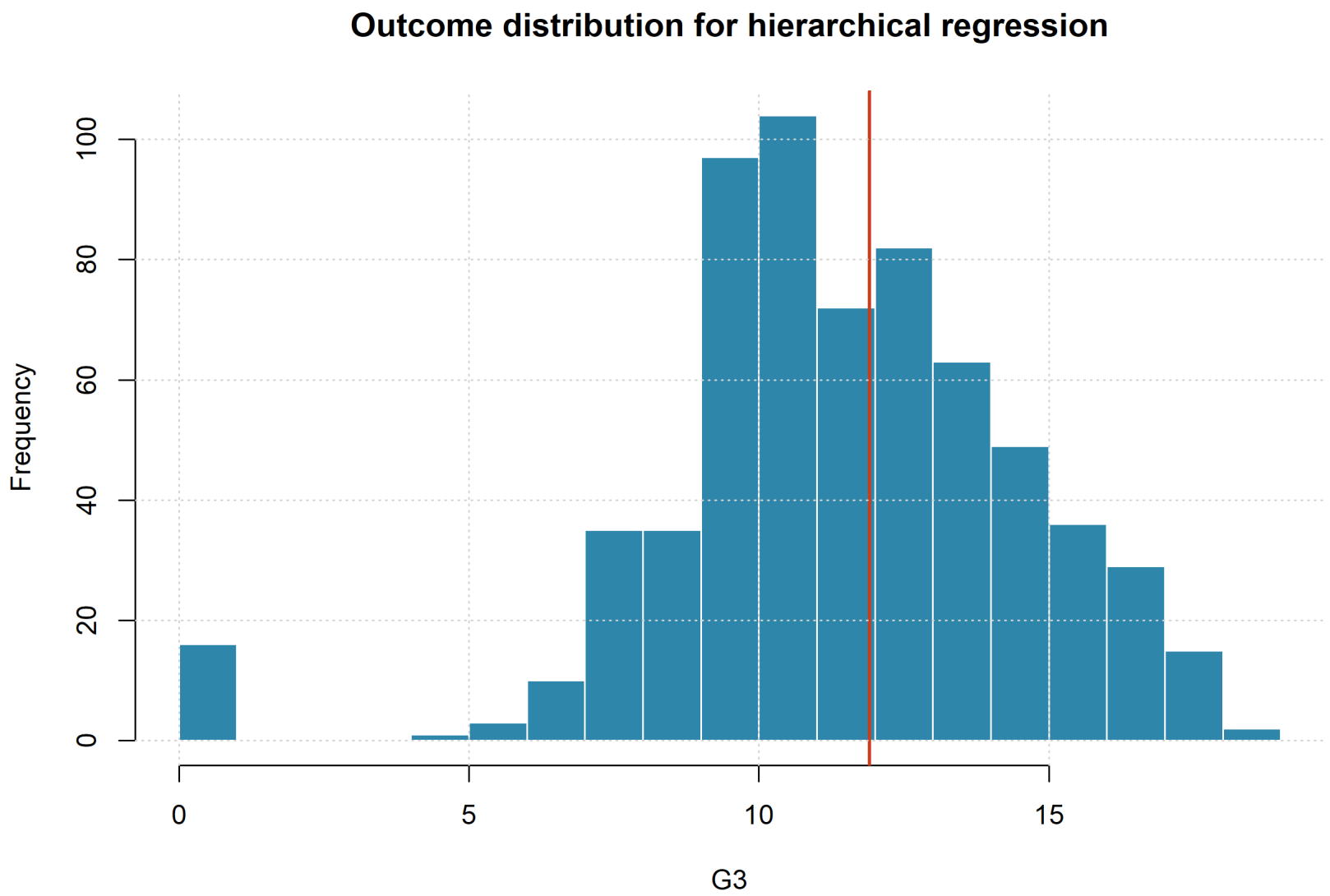
Final model coefficients

block	model	term	coefficient	standard_error	t_value	p_value	ci95_lower	ci95_upper	decision_alpha_0_05
3	Block 3 − Family, support, and behavioral variables	(Intercept)	−0.07035912	0.92196867	−0.0763140	9.391939e−01	−1.880918970	1.74020073	Not statistically significant
3	Block 3 − Family, support, and behavioral variables	age	0.03994069	0.04639779	0.8608317	3.896635e−01	−0.051175182	0.13105657	Not statistically significant
3	Block 3 − Family, support, and behavioral variables	factor(school)MS	−0.21708570	0.12367662	−1.7552687	7.970720e−02	−0.459961535	0.02579014	Not statistically significant
3	Block 3 − Family, support, and behavioral variables	factor(sex)M	−0.13598899	0.11675887	−1.1646994	2.445886e−01	−0.365279778	0.09330180	Not statistically significant
3	Block 3 − Family, support, and behavioral variables	factor(address)U	0.14687100	0.12108434	1.2129645	2.256053e−01	−0.090914133	0.38465614	Not statistically significant
3	Block 3 − Family, support, and behavioral variables	factor(famsize)LE3	0.04962801	0.11431726	0.4341253	6.643485e−01	−0.174867947	0.27412397	Not statistically significant
3	Block 3 − Family, support, and behavioral variables	factor(Pstatus)T	−0.10756241	0.15934817	−0.6750150	4.999179e−01	−0.420489960	0.20536514	Not statistically significant
3	Block 3 − Family, support, and behavioral variables	G1	0.12362315	0.03747466	3.2988467	1.026413e−03	0.050030509	0.19721580	Statistically significant
3	Block 3 − Family, support, and behavioral variables	G2	0.87489561	0.03485503	25.1009888	1.764231e−96	0.806447392	0.94334382	Statistically significant
3	Block 3 − Family, support, and behavioral variables	studytime	0.04363375	0.06512530	0.6699969	5.031092e−01	−0.084259161	0.17152666	Not statistically significant
3	Block 3 − Family, support, and behavioral variables	failures	−0.22059439	0.09748738	−2.2627995	2.399316e−02	−0.412039862	−0.02914891	Statistically significant
3	Block 3 − Family, support, and behavioral variables	absences	0.01482369	0.01157386	1.2807911	2.007459e−01	−0.007905019	0.03755240	Not statistically significant

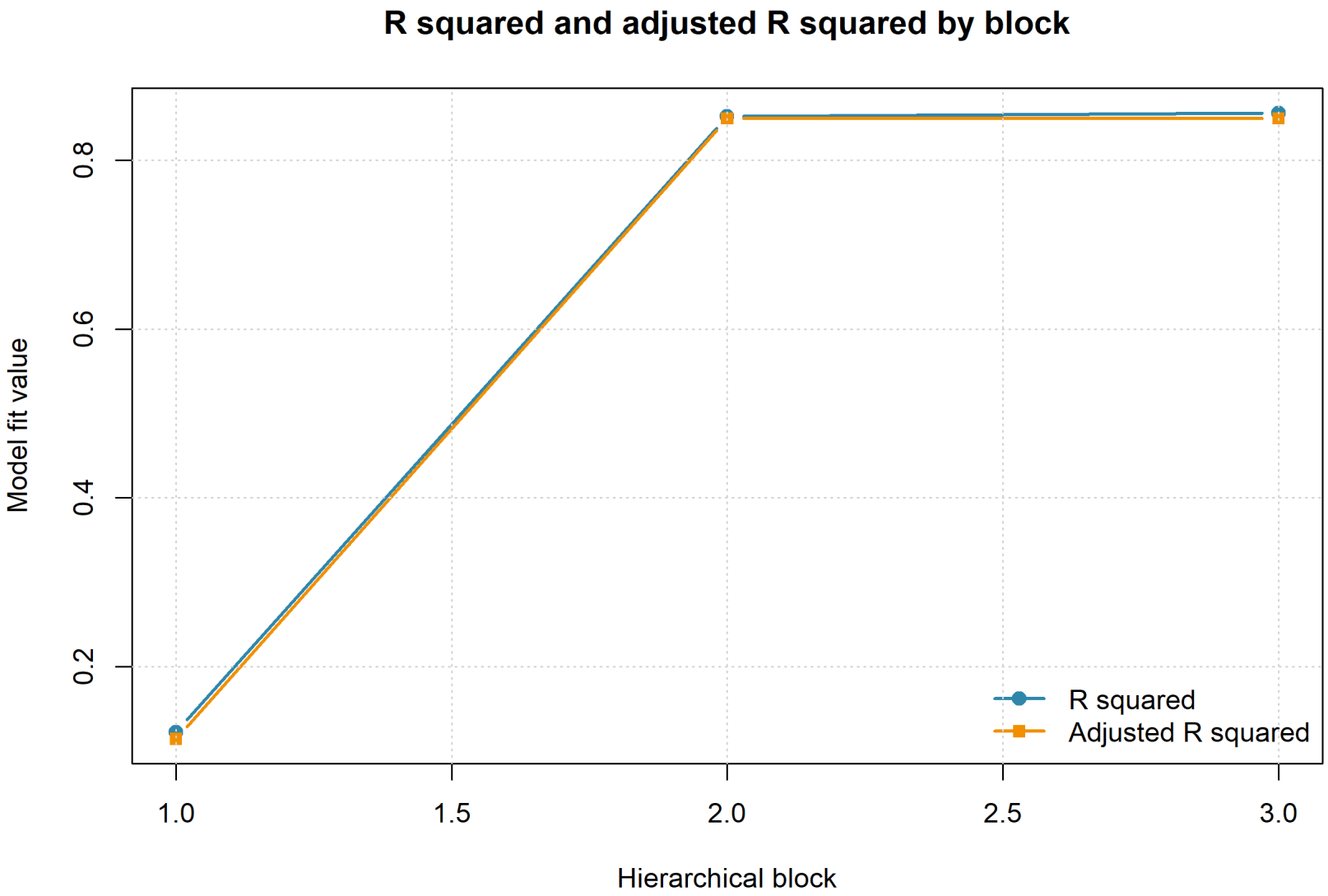
Block definitions

block	block_name	numeric_variables_used	categorical_variables_used	purpose
1	Block 1 − Background and demographics	age	school, sex, address, famsize, Pstatus	Controls for student background before academic predictors are added.
2	Block 2 − Prior achievement and academic variables	G1, G2, studytime, failures, absences	schoolsup, famsup, paid, activities, nursery, higher, internet, romantic	Tests whether achievement and study variables improve prediction after background controls.
3	Block 3 − Family, support, and behavioral variables	Medu, Fedu, traveltime, famrel, freetime, goout, Dalc, Walc, health		Tests whether additional family, support, and behavior variables explain extra variance.

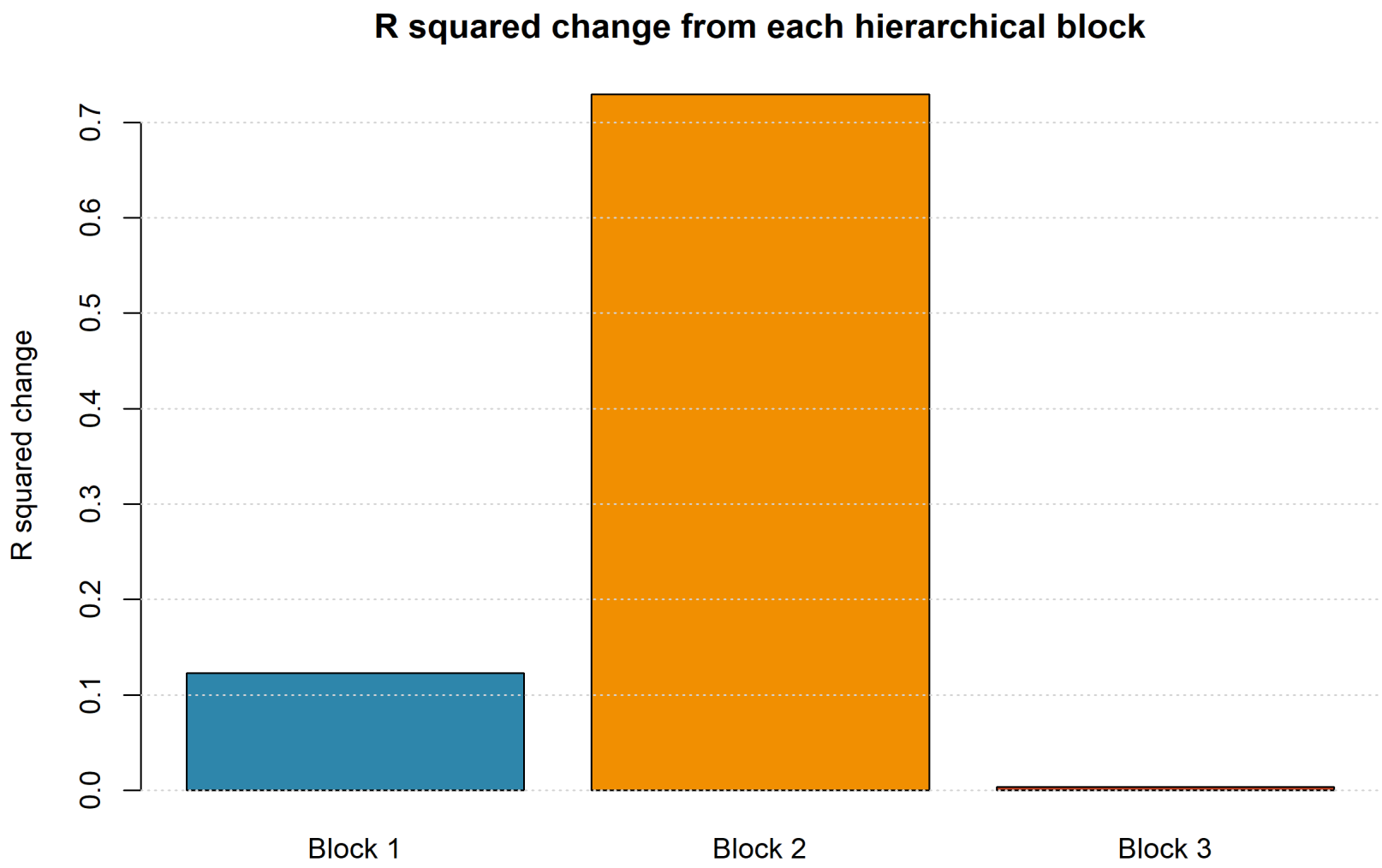
01_hierarchical_regression_outcome_distribution.png



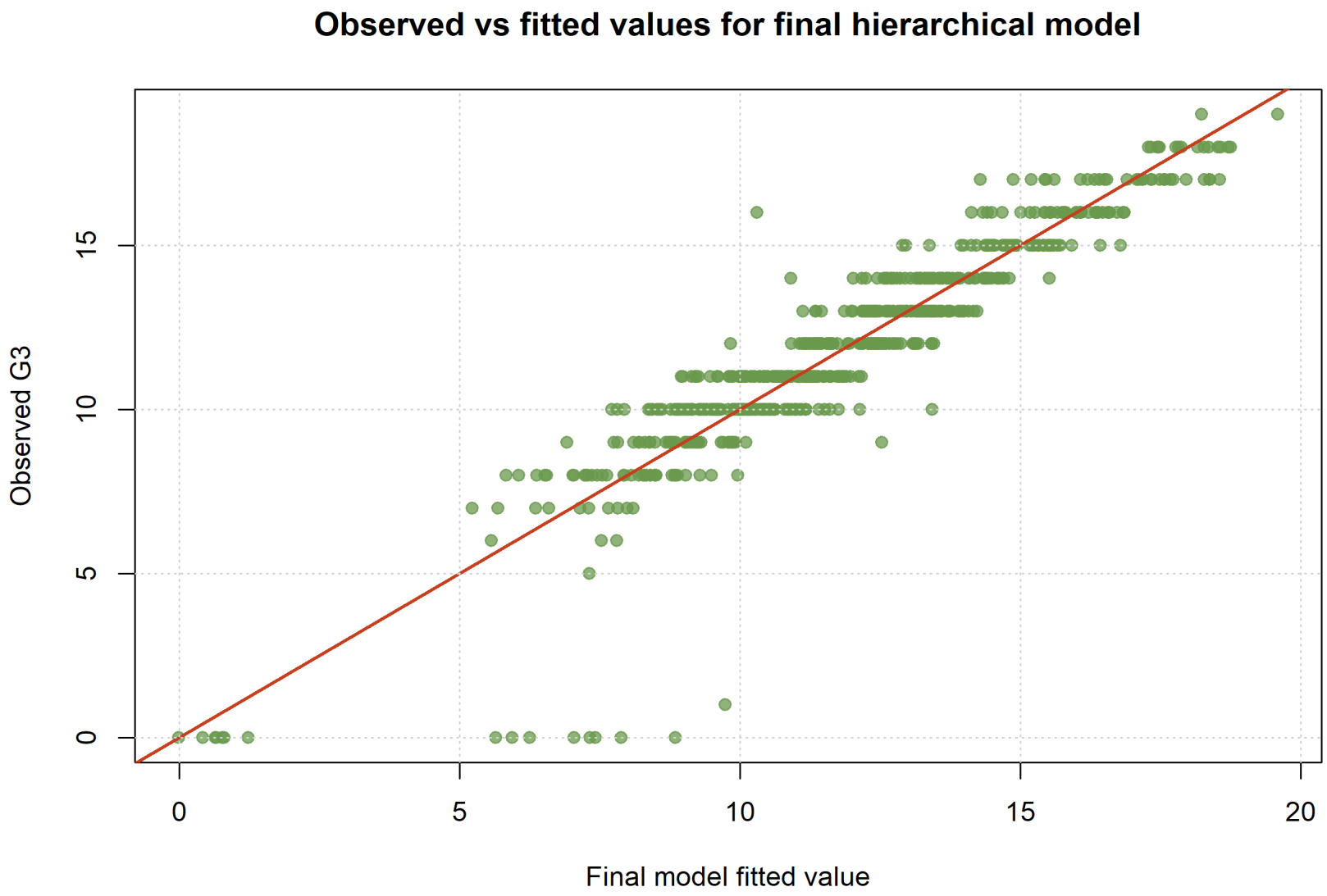
02_hierarchical_regression_r2_adjusted_r2_by_block.png



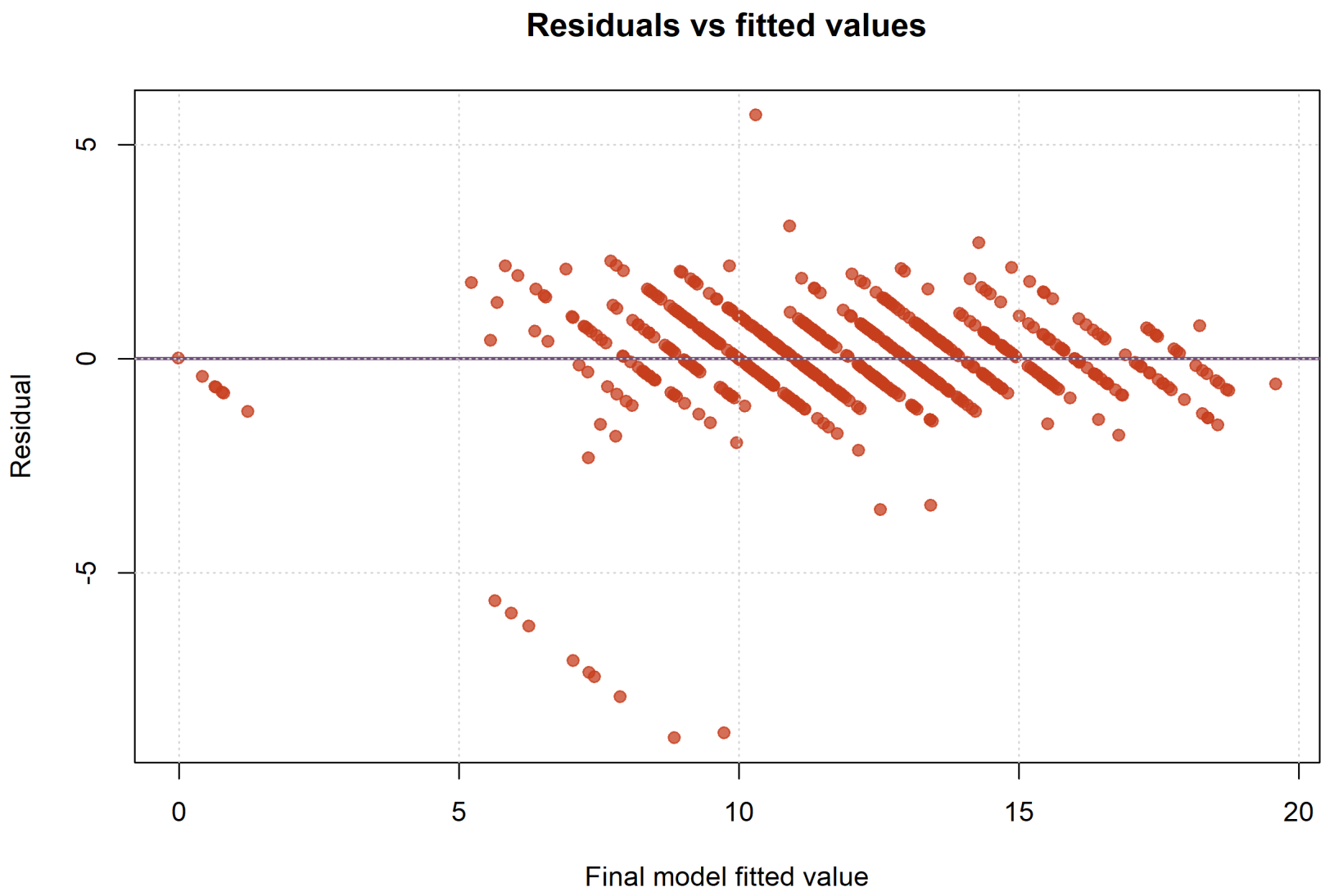
03_hierarchical_regression_r2_change.png



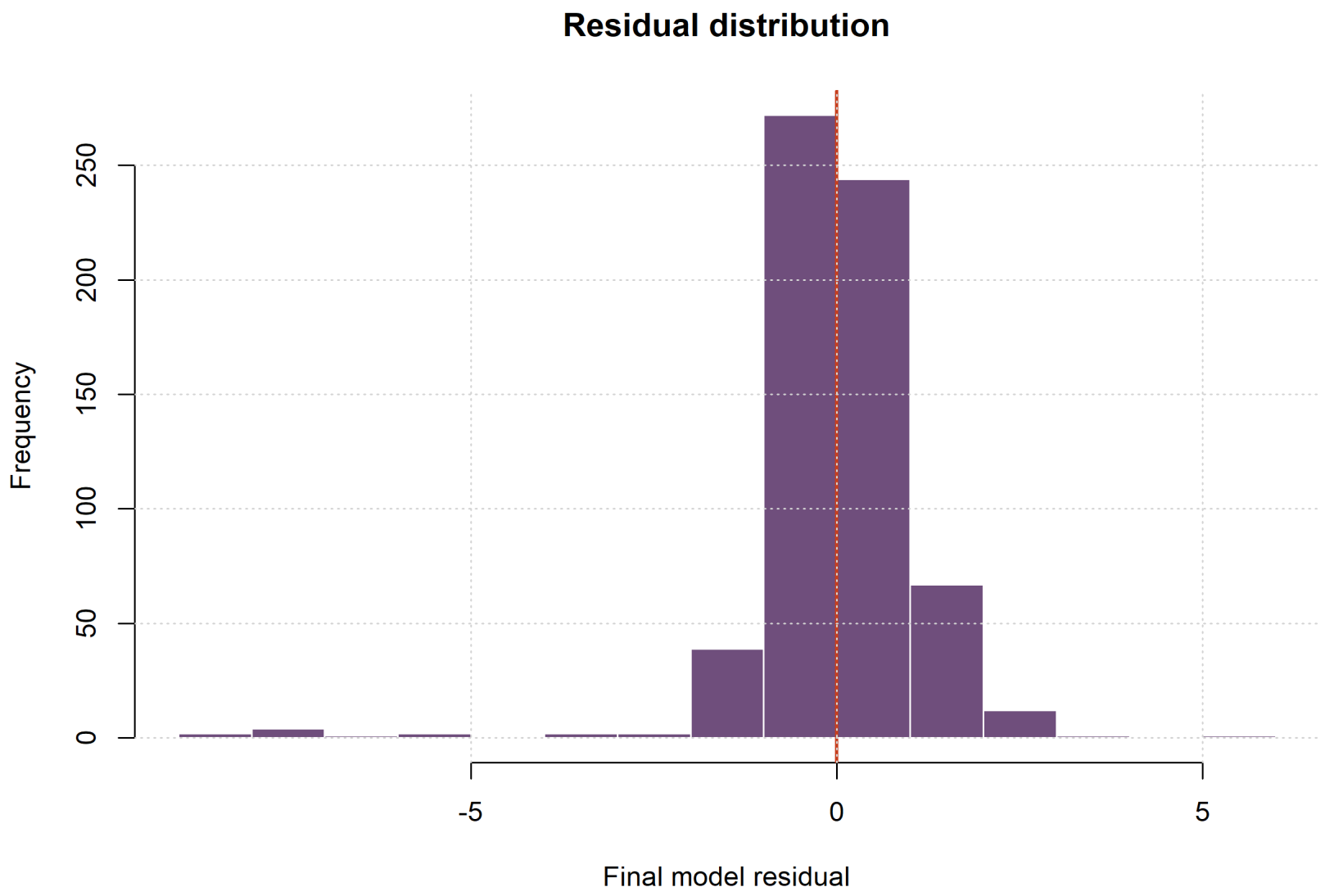
04_hierarchical_regression_observed_vs_fitted.png



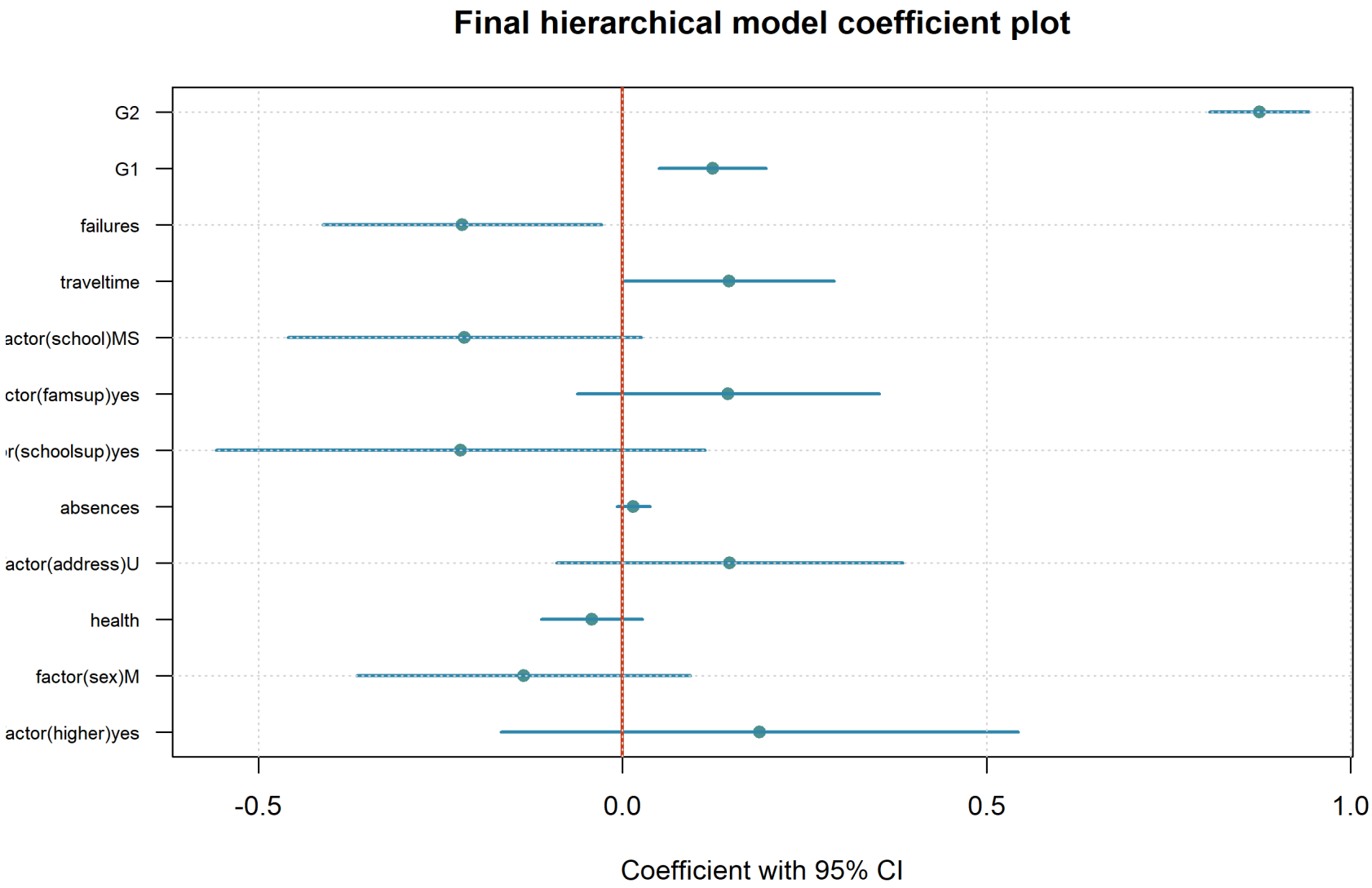
05_hierarchical_regression_residuals_vs_fitted.png



06_hierarchical_regression_residual_distribution.png



07_hierarchical_regression_final_coefficients.png



08_hierarchical_regression_prediction_error_by_block.png