

Causality, Control Variables, and Conditional Mean Independence; Internal & External Validity

Outline

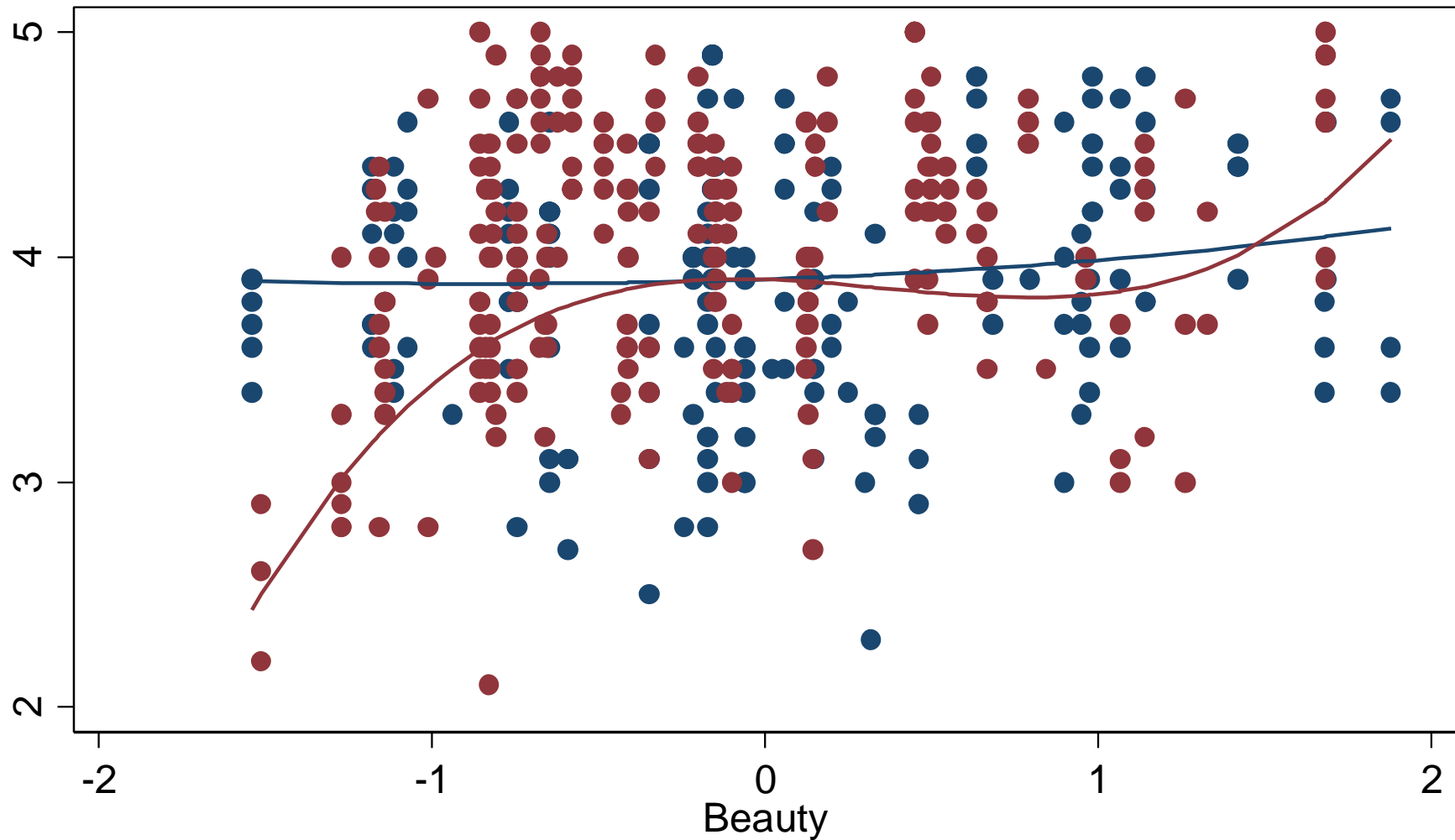
1. Causality in statistical experiments
2. Omitted variable bias (again)
3. Control variables and conditional mean independence
4. Internal and external validity

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                |
                |           Robust
courseeval~n |           Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
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    btystdave |           .049012   .0905383     0.54   0.589    - .1289226     .2269466
      male    |          -2.697054   1.36349    -1.98   0.049    -5.376716    - .0173915
      bty2    |           .0327519   .0499135     0.66   0.512    - .0653429     .1308467
      bty3    |           .0029834   .0482024     0.06   0.951    - .0917486     .0977154
    bty_male  |          - .0964114   .1194252    -0.81   0.420    - .3311174     .1382946
    bty2_male |          - .3005362   .0694863    -4.33   0.000    - .4370974    - .163975
    bty3_male |           .2458653   .0679643     3.62   0.000     .1122953     .3794352
      age     |          - .0366662   .0541871    -0.68   0.499    - .1431599     .0698276
      age2    |           .0002953   .0006123     0.48   0.630    - .000908     .0014987
    age_male  |           .1126335   .061227     1.84   0.066    - .0076957     .2329627
    age2_male |          - .0009927   .0006737    -1.47   0.141    - .0023168     .0003313
    minority  |          - .107427   .0757036    -1.42   0.157    - .256207     .041353
    nonenglish |          - .3249134   .1068987    -3.04   0.003    - .5350012    - .1148256
    tenuretrack |           .0255414   .0641215     0.40   0.691    - .1004764     .1515592
      lower   |          - .0089454   .0565692    -0.16   0.874    - .1201207     .1022299
    onecredit |           .5742187   .1032149     5.56   0.000     .3713708     .7770666
      _cons   |           4.905785   1.165435     4.21   0.000     2.615358     7.196212
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Scatterplot and cubic fits for men and women

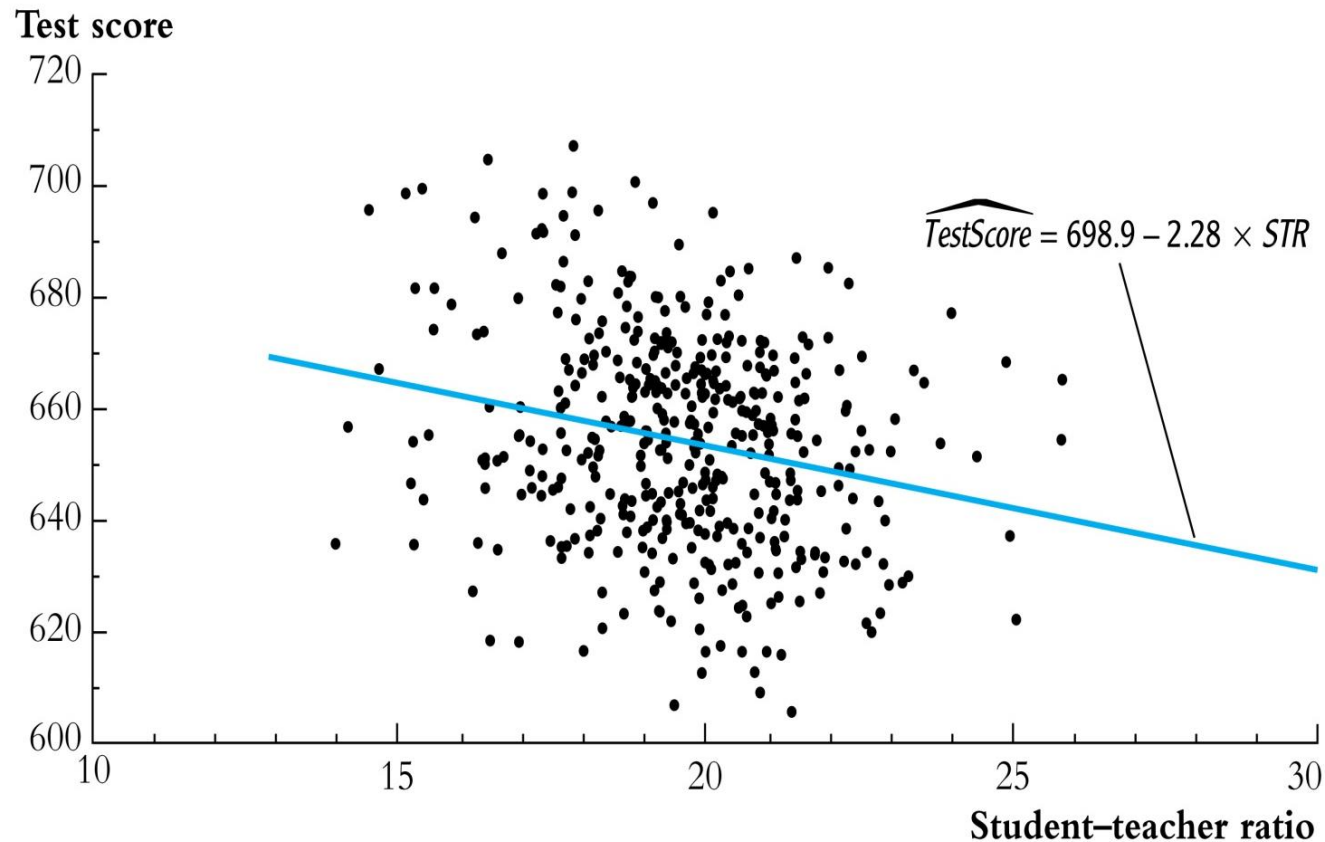


The Class Size/Test Score Relation in California

Issue: effect of class size on elementary student achievement.

Data: $n = 420$ California school districts, 1998-99

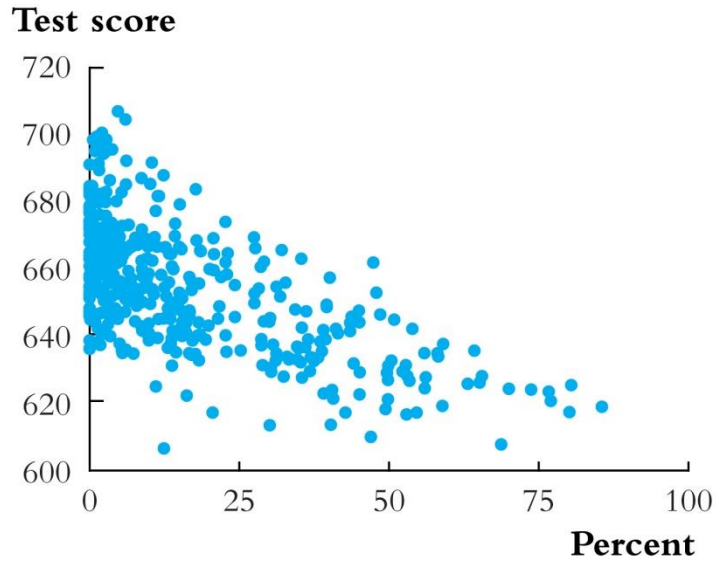
Test score: district average 5th grade Stanford Achievement Test



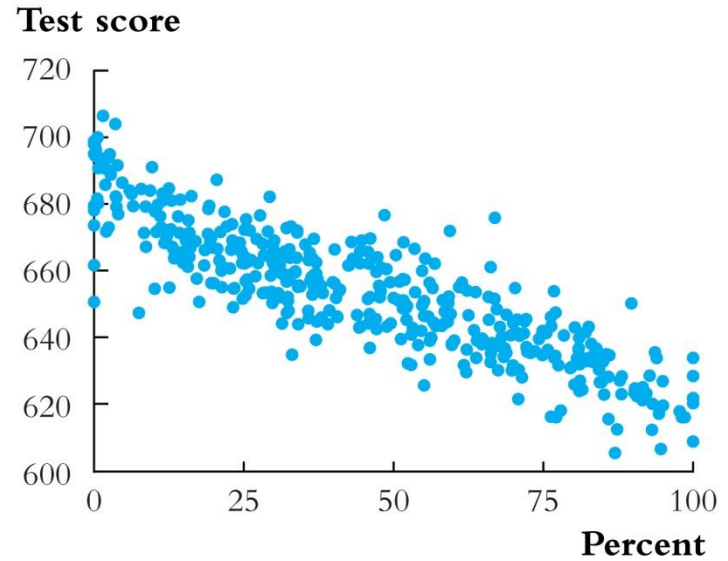
$$TestScore = 698.9 - 2.28STR, R^2 = 0.049, SER = 18.58$$

(10.4) (0.52)

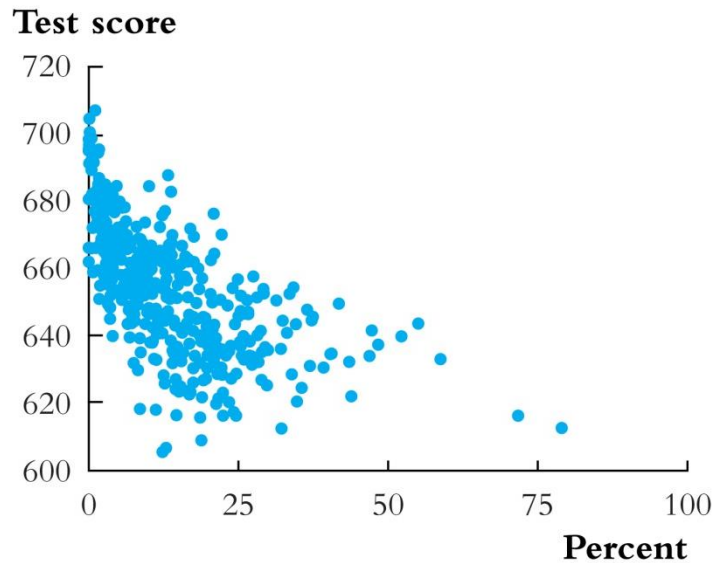
Some California data scatterplots



(a) Percentage of English language learners



(b) Percentage qualifying for reduced price lunch



(c) Percentage qualifying for income assistance

TABLE 7.1 Results of Regressions of Test Scores on the Student–Teacher Ratio and Student Characteristic Control Variables Using California Elementary School Districts

Dependent variable: average test score in the district.

Regressor	(1)	(2)	(3)	(4)	(5)
Student–teacher ratio (X_1)	–2.28** (0.52)	–1.10* (0.43)	–1.00** (0.27)	–1.31** (0.34)	–1.01** (0.27)
Percent English learners (X_2)		–0.650** (0.031)	–0.122** (0.033)	–0.488** (0.030)	–0.130** (0.036)
Percent eligible for subsidized lunch (X_3)			–0.547** (0.024)		–0.529** (0.038)
Percent on public income assistance (X_4)				–0.790** (0.068)	0.048 (0.059)
Intercept	698.9** (10.4)	686.0** (8.7)	700.2** (5.6)	698.0** (6.9)	700.4** (5.5)
Summary Statistics					
<i>SER</i>	18.58	14.46	9.08	11.65	9.08
\bar{R}^2	0.049	0.424	0.773	0.626	0.773
<i>n</i>	420	420	420	420	420

These regressions were estimated using the data on K-8 school districts in California, described in Appendix 4.1. Standard errors are given in parentheses under coefficients. The individual coefficient is statistically significant at the *5% level or **1% significance level using a two-sided test.

Internal and External Validity

Internal validity: the statistical inferences about causal effects are valid for the population being studied.

Threats to the internal validity of regression studies:

1. Omitted variable bias
2. Wrong functional form
3. Errors-in-variables bias
4. Sample selection bias
5. Simultaneous causality bias
6. “Wrong” standard errors

External validity: the statistical inferences can be generalized from the population and setting studied to other populations and settings, where the “setting” refers to the legal, policy, and physical environment and related salient features.

Threats to internal validity:

1. Omitted variable bias
2. Wrong functional form
3. Errors-in-variables bias
4. Sample selection bias
5. Simultaneous causality bias
6. “Wrong” standard errors

- #1-5 lead to $E(u_i|X_i) \neq 0$ – so OLS is biased and inconsistent
- #6 results in hypothesis tests that have the wrong size (rejection rate under the null) and confidence intervals that have the wrong coverage rate.
 - This problem is easy to fix – use heteroskedasticity-robust SEs with cross-sectional data and cluster standard errors with panel data.