PLSC 503: "Multivariate Analysis for Political Research"

Exercise One
January 23, 2023

Introduction

In this exercise, you'll use linear/matrix algebra software – that is, the matrix algebra operators in R – to estimate a linear regression, and then cross-check those results using lm. The point is to demonstrate both a basic grasp of the software and your understanding of the matrix-algebra representation of the classical linear regression model. The data are this:

Observation	Y	X_1	X_2	X_3	X_4
1	39	0.3	8	0	13229
2	-18	0.1	111	1	7188
3	13	0.7	79	1	8404
4	19	1.1	13	1	8109
5	6	0	91	0	10066
6	-2	0.1	43	1	9003
7	15	1.5	52	0	14014
8	-11	0	98	1	10999
9	17	0.9	22	0	12876
10	3	0.2	106	1	7977

Exercise

Using the linear algebra functions in R (or, e.g., the mata/matrix commands in Stata), do the following:

1. Estimate the $\hat{\beta}$s and their variances and covariances $\widehat{\text{Var}(\hat{\beta})}$ for the OLS equation:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + u_i.$$

2. Calculate the predicted $\hat{Y}_i$s, and the estimated residuals (the $\hat{u}_i$s).

3. Calculate the estimated root mean squared error (RMSE), the R^2, and the R^2_{adj}.

4. Calculate the standard errors of the estimated $\hat{\beta}$s, as well as their covariances.

5. Calculate a t-test for the hypothesis that $\beta_2 = 0$.

6. Calculate an F-test for the joint hypothesis that $\beta_1 = \beta_2 = \beta_3 = 0$.

7. Calculate an F-test for the hypothesis that $\beta_1 = -10 \times \beta_2$.

8. Check all your results using lm / linearHypothesis / etc.

Be sure to include *all* code that you used to complete the various steps above.

This assignment is due no later than Friday, February 3, 2023 at 11:59 p.m. EDT. You can submit your homework by emailing copies **both** to Dr. Zorn (zorn@psu.edu) <u>and</u> Ms. Sendinc (tzs5636@psu.edu). In addition to your responses to the items above, please include all code used in the exercise. This assignment is worth 50 possible points.