## Exercise 12

ANCOVA

Average salary paid to teachers and expenditures per pupil are two commonly used measures of the amount of money spent on education. Data on these two measures are provided by state, and states are classified in two regions: north and south. Teachers' pay may be used to predict educational spending, and vice versa. There appear to be regional differences in both teachers' pay and educational spending. Perform an ANCOVA test in order to find out whether *region* and *teacher's pay* predict *educational spending*.

Columns in the table:

State: State
Region: Region
Pay: Amount of pay in thousands
Spend: Average amount spent per student in thousands

(Reference: Moore, David S., and George P. McCabe (1989). *Introduction to the Practice of Statistics*. Original source: data compiled by the National Education Association and reported in The New York Times, November 8, 1986. Download from *The Data and Story Library*, see http://lib.stat.cmu.edu/DASL/)

Download the table education.sav from: http://www.let.rug.nl/~heeringa/statistics/stat03_2013/ and load the table in SPSS.

1. Check whether there is a dependency between Region and Pay. Use an ANOVA test.

2. Homogeneity of regression slopes. Check wether the regression slopes are the same for the two regions. For each region make a scatterplot with Pay in the $x$-axis and Spend on the $y$-axis.

3. Check the assumption of homogeneity of regression slopes with an ANCOVA test, where the interaction Region × Pay is added. Look at the row *Region * Pay* in the table *Tests of Between-Subjects Effects*.

4. Perform the ANCOVA test, but now without the interaction being included. The Levene's test will also be carried out. Save also the residuals.

5. Create a normal quantile plot of the residuals and perform the Shapiro-Wilk test on the basis of the residuals. Are the residuals normally distributed?

6. Who do you conclude from the Levene's test? Are the variances the same across the two regions?

7. Look at the results of the latter ANCOVA test. Look at the table *Tests of Between-Subjects Effects*. What do you conclude?

8. Report also the effect size(s) for the significant main effect(s).