Module 5: Introduction to Multilevel Modelling SPSS Practicals

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Pre-requisites

- Modules 1-4

Contents

[1] This SPSS practical is adapted from the corresponding MLwiN practical: Steele, F. (2008) Module 5: Introduction to Multilevel Modelling. LEMMA VLE, Centre for Multilevel Modelling. Accessed at http://www.cmm.bris.ac.uk/lemma/course/view.php?id=13.

Some of the sections within this module have online quizzes for you to test your understanding. To find the quizzes:

EXAMPLE
From within the LEMMA learning environment

- Go down to the section for Module 5: Introduction to Multilevel Modelling
- Click "5.1 Comparing Groups Using Multilevel Modelling" to open Lesson 5.1
- Click Q 1 to open the first question

Introduction to the Scottish Youth Cohort Trends Dataset

You will be analysing data from the Scottish School Leavers Survey (SSLS), a nationally representative survey of young people. We use data from seven cohorts of young people collected in the first sweep of the study, carried out at the end of the final year of compulsory schooling (aged 16-17) when most sample members had taken Standard grades[2].

In the practical for Module 3 on multiple regression, we considered the predictors of attainment in Standard grades (subject-based examinations, typically taken in up to eight subjects). In this practical, we extend the (previously single-level) multiple regression analysis to allow for dependency of exam scores within schools and to examine the extent of between-school variation in attainment. We also consider the effects on attainment of several school-level predictors.

The dependent variable is a total attainment score. Each subject is graded on a scale from 1 (highest) to 7 (lowest) and, after recoding so that a high numeric value denotes a high grade, the total is taken across subjects.

The analysis dataset contains the student-level variables considered in Module 3 together with a school identifier and three school-level variables:

Variable name	Description and codes
CASEID	Anonymised student identifier
SCHOOLID	Anonymised school identifier
SCORE	Point score calculated from awards in Standard grades taken at age 16. Scores range from 0 to 75, with a higher score indicating a higher attainment
COHORT90	The sample includes the following cohorts: 1984, 1986, 1988, 1990, 1996 and 1998. The

[2] We are grateful to Linda Croxford (Centre for Educational Sociology, University of Edinburgh) for providing us with these data. The dataset was constructed as part of an ESRC-funded project on Education and Youth Transitions in England, Wales and Scotland 1984-2002. Further analyses of the data can be found in Croxford, L. and Raffe, D. (2006) Education Markets and Social Class Inequality: A Comparison of Trends in England, Scotland and Wales". In R. Teese (Ed.) Inequality Revisited. Berlin: Springer.

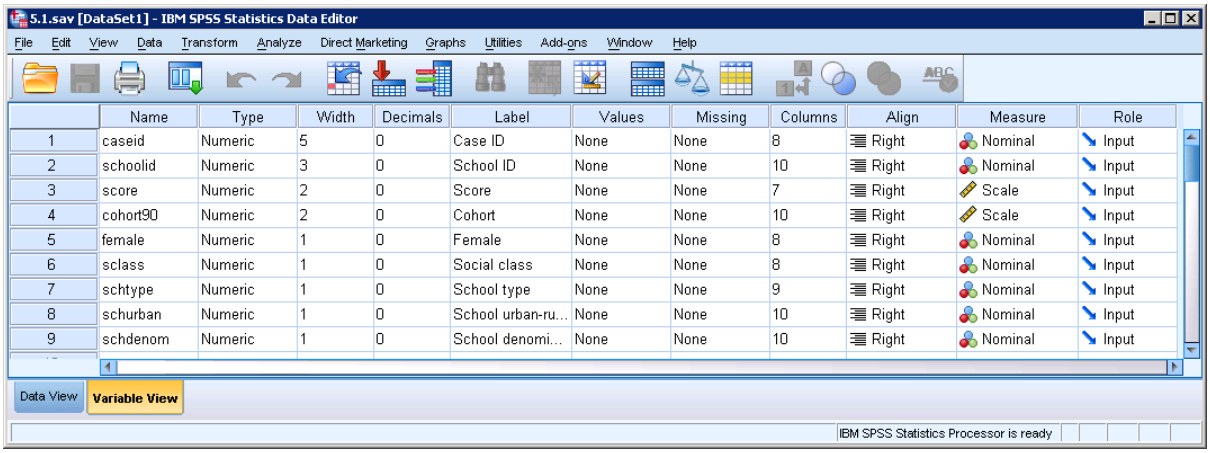
	COHORT90 variable is calculated by subtracting 1990 from each value. Thus values range from -6 (corresponding to 1984) to 8 (1998), with 1990 coded as zero
FEMALE	Sex of student (1=female, 0=male)
SCLASS	Social class, defined as the higher class of mother or father (1=managerial and professional, 2=intermediate, 3=working, 4=unclassified).
SCHTYPE	School type, distinguishing independent schools from state-funded schools (1=independent, 0=state-funded)
SCHURBAN	Urban-rural classification of school (1=urban, 0=town or rural)
SCHDENOM	School denomination (1=Roman Catholic, 0=non-denominational)

There are 33988 students in 508 schools.

Open the worksheet to

From within the LEMMA Learning Environment
- Go to **Module 5: Introduction to Multilevel Modelling**, and scroll down to **SPSS Datafiles**
- Click "5.1.sav"

You will see the Data Editor Window, after switching to Variable View:



P5.1 Comparing Groups using Multilevel Modelling

P5.1.1 A multilevel model of attainment with school effects

We will start with the simplest multilevel model which allows for school effects on attainment, but without explanatory variables. This 'null' model may be written

$$y_{ij} = \beta_0 + u_j + e_{ij} \quad (5.1)$$

where y_{ij} is the attainment of student *i* in school *j* , β_0 is the overall mean across schools, u_j is the effect of school *j* on attainment, and e_{ij} is a student level residual. The school effects u_j, which we will also refer to as school (or level 2) residuals, are assumed to follow a normal distribution with mean zero and variance σ_u^2.

To run this model in SPSS we will use the MIXED command. Immediately after MIXED there is the response variable. The /FIXED option specifies the variables to include in the fixed part, in this case this is empty as the intercept is automatically included, and there are no other predictors in the fixed part. The /METHOD option allows selection of the estimation method, in this case maximum likelihood. /PRINT=SOLUTION requests that the parameter estimates are displayed after fitting. The /RANDOM option specifies which variables are included in the random part, as well as specifying the variable that defines the grouping (here, schools). Finally the /SAVE option specifies that we want to save the fixed-part prediction (FIXPRED), the prediction including random effects (PRED) and the standard errors of the prediction (SEPRED) back into the data set. Note that unlike software such as MLwiN the data does not have to be sorted a specific way in order to fit the model.

```
MIXED score
  /FIXED=|
  /METHOD=ML
  /PRINT=SOLUTION
  /RANDOM=INTERCEPT | SUBJECT(schoolid)
  /SAVE=FIXPRED PRED SEPRED.
```

Alternatively:

- Analyze>Mixed Models>Linear…
- Add schoolid to "Subjects"
- Click "Continue"
- Add score to "Dependent Variable"
- Click "Random"
- Tick "Include intercept"
- Add schoolid to "Combinations"
- Click "Continue"
- Click "Estimation"
- Tick "Maximum Likelihood (ML)"
- Click "Continue"

- Click “Statistics”
- Tick “Parameter estimates”
- Click “Continue”
- Click “Save…”
- Tick Predicted values under “Fixed Predicted Values”
- Tick Predicted values under “Predicted Values & Residuals”
- Tick Standard errors under “Predicted Values & Residuals”
- Click “Continue”
- Click “OK”

We will see the following tables of results (the “Model Dimension” and “Type III Tests of Fixed Effects” tables are not of interest for this analysis, so we will omit them from subsequent results):

Model Dimension[a]

		Number of Levels	Covariance Structure	Number of Parameters	Subject Variables
Fixed Effects	Intercept	1		1	
Random Effects	Intercept	1	Variance Components	1	schoolid
Residual				1	
Total		2		3	

a. Dependent Variable: Score.

Information Criteria[a]

-2 Log Likelihood	286539.064
Akaike's Information Criterion (AIC)	286545.064
Hurvich and Tsai's Criterion (AICC)	286545.065
Bozdogan's Criterion (CAIC)	286573.365
Schwarz's Bayesian Criterion (BIC)	286570.365

The information criteria are displayed in smaller-is-better forms.

a. Dependent Variable: Score.

Type III Tests of Fixed Effects[a]

Source	Numerator df	Denominator df	F	Sig.

Intercept	1	451.533	6861.108	.000

a. Dependent Variable: Score.

Estimates of Fixed Effects[a]

						95% Confidence Interval	
Parameter	Estimate	Std. Error	df	t	Sig.	Lower Bound	Upper Bound
Intercept	30.600595	.369430	451.533	82.832	.000	29.874579	31.326612

a. Dependent Variable: Score.

Estimates of Covariance Parameters[a]

Parameter		Estimate	Std. Error
Residual		258.357255	1.997715
Intercept [subject = schoolid]	Variance	61.024127	4.475315

a. Dependent Variable: Score.

The overall mean attainment (across schools) is estimated as 30.60. The mean for school *j* is estimated as 30.60 + $\hat{u}_{0j}$, where $\hat{u}_{0j}$ is the school residual which we will estimate in a moment. A school with $\hat{u}_{0j}$ > 0 has a mean that is higher than average, while $\hat{u}_{0j}$ < 0 for a below-average school. (We will obtain confidence intervals for residuals to determine whether differences from the overall mean can be considered 'real' or due to chance.)

Partitioning variance

The between-school (level 2) variance in attainment is estimated as $\hat{\sigma}^2_{u0}$ = 61.02, and the within-school between-student (level 1) variance (labelled 'Residual' in the output) is estimated as $\hat{\sigma}^2_{u0}$ =258.36. Thus the total variance is 61.02+258.36=319.38.

The variance partition coefficient (VPC) is 61.02/319.38 = 0.19, which indicates that 19% of the variance in attainment can be attributed to differences between schools. Note, however, that we have not accounted for intake ability (measured by exams taken on entry to secondary school) so the school effects are not value-added. Previous studies have found that between-school variance in progress, i.e. after accounting for intake attainment, is typically close to 10%.

Testing for school effects

This document is only the first few pages of the full version.

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