Running a random components mixed model in XLSTAT

demoMIX.xls

Dataset for running a random components mixed model

An Excel sheet with both the data and the results can be downloaded by clicking here.

We use a dataset coming from Mendenhall, Wackerly and Schaeffer (1996, Mathematical Statistics with Applications, Duxbury Press). In this example, ingots made up of various metals are studied. We seek to know the impact of the treated ingot and the type of metal being used as bond in this ingot (N: nickel, I: iron and C: copper) on the necessary pressure to break it into two. We have 7 ingots, three types of bonds and a dependent variable. The treated ingots are drawn from a larger population and thus constitute a random factor in our model.

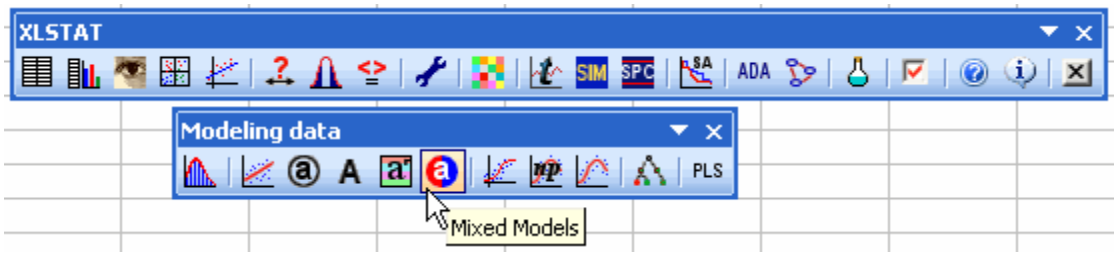
A mixed linear model is based on the same model as a traditional linear model with a term associated with the random effects. The model will have the following form:

$$Y = X\beta + Z\gamma + e$$

In our case, Y is the press variable, X is the bond (fixed factor) and Z is the ingot (random factor). Moreover, we can choose the structure of the covariance matrix of the random effects. We will choose a structure called "variance component" which is based on a diagonal matrix. Please consult the help of XLSTAT for more details on covariance structure.

Setting up a random components mixed model

After opening XLSTAT, select the **XLSTAT / Modeling data / Mixed models** command, or click on the corresponding button of the **Modeling data** toolbar (see below).



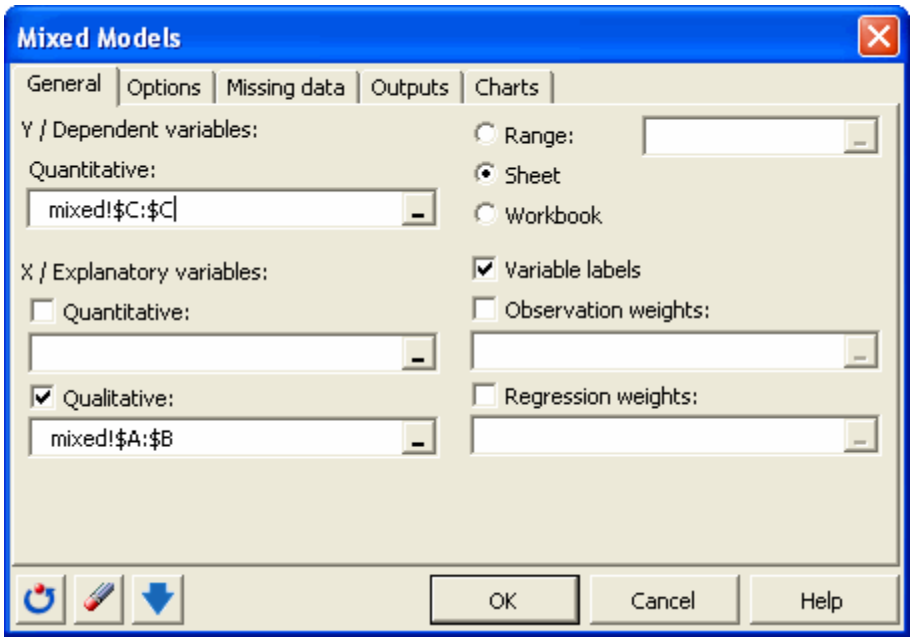
Once you've clicked on the button, the mixed model dialog box appears.

Select the data on the Excel sheet.

The **Dependent variable** (or variable to model) is here the "pressure".

Our aim is to determine the effect of the bond and of the ingot on the variability of the pressure.

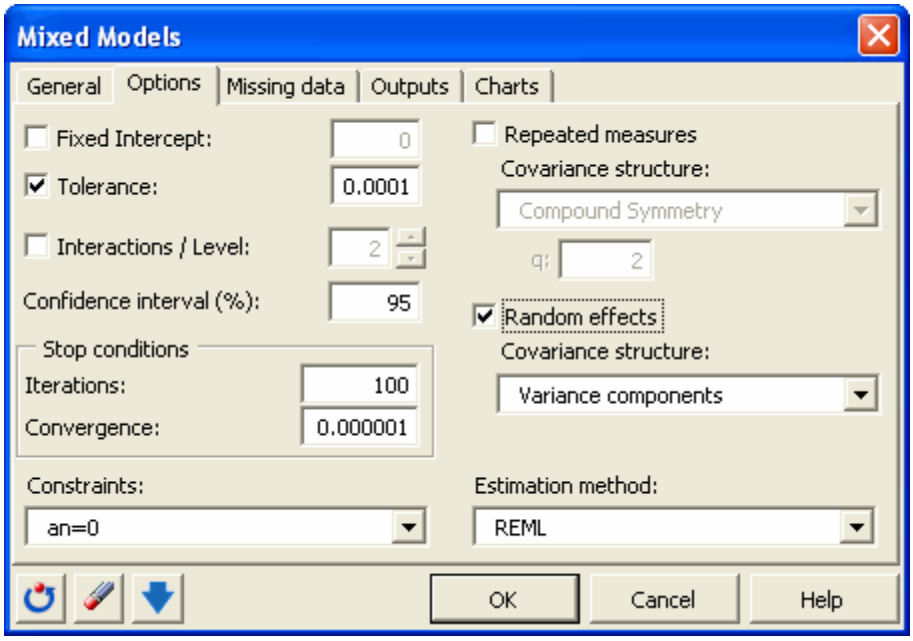
As we selected the column title for the variables, we left the option **Variable labels** activated.



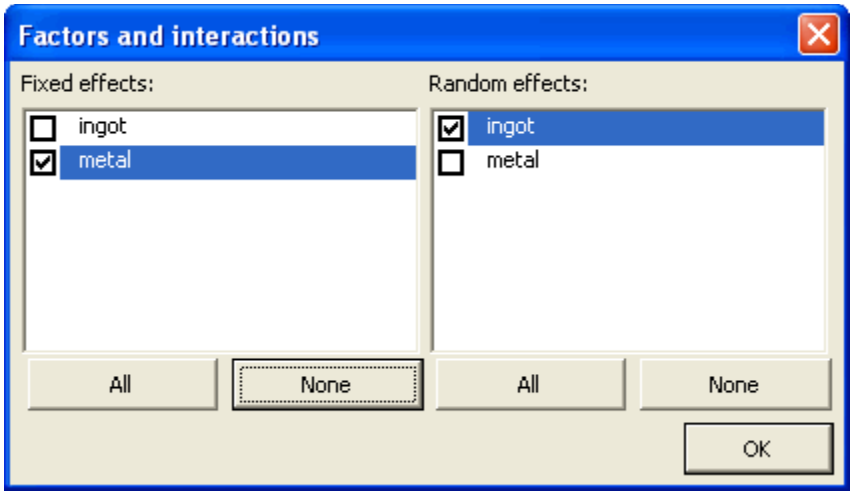
We left the constraint option at **an=0**, meaning that we want the model to be built on the assumption that the copper has the standard effect on the pressure.

When dealing with qualitative variables, although you have to apply a constraint to the model in ANOVA for theoretical reasons, it will not affect the results (goodness of fit). The only difference it makes is in the actual writing of the model.

The covariance structure selected is the default one which is variance component.



Once you have clicked on the **OK** button, a dialog box is displayed so that you can choose which factors have to be taken into account in the model. The **fixed effect** is the "metal" and the **random effect** is the "ingots".



Note: A factor cannot be random and fixed.

Once you have clicked on the “OK” button, the computation starts. The results will then be displayed.

Interpreting the results of a random components mixed model

The first results displayed by XLSTAT are the goodness of fit coefficients.

Goodness of fit statistics:	
Observations	21
Sum of weights	21
-2 Res Log(Likelihood)	107,790
AIC	111,790
AICC	112,457
SBC	113,879
CAIC	115,879
Iterations	7
Covariance parameters	2
Number of fixed effects	1
Number of random effects	1
Number of subjects	1
Maximum number of observa	21

Model parameters are obtained using the restricted maximum likelihood (REML) method and will be different as when a classical linear model is applied. All indexes are used to compare models with different covariance structures.

Covariance parameters tables are then displayed. The first one is associated to the random components of the model and the second table is associated to the error covariance matrix. In our case as there is no repeated measures, the error covariance matrix is diagonal with one value associated to the variance.

You can display full covariance matrix when selecting G matrix (random component covariance) and R matrix (error covariance) in the output dialog box.

We can see that the error variance is significant and the random component variance is not significant. The random component will not have a significant effect on the global model.

Covariance parameters - Random effects:				
	Parameter	standard err	Z	Pr > Z
Variance	11,448	8,720	1,313	0,095
Covariance parameters - Repeated factor:				
	Parameter	standard err	Z	Pr > Z
Variance	10,372	4,234	2,450	0,007

To understand the effect of fixed effects on the model, we study the Type III tests of fixed effects. We can see that the metal has a significant effect on the model.

Type III tests of fixed effects:				
Effects	Num DF	Den DF	F	Pr > F
metal	2	12	6,359	0,013

The used metal has a significant effect on the necessary pressure to break the ingot.

When we look at the model parameters (see below), we can see that using iron as bond for the ingot makes a significant increase on the necessary pressure. Using nickel does not make a significant difference.

Model parameters:						
Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	70,186	1,766	39,754	< 0,0001	66,514	73,857
metal-n	0,914	1,721	0,531	0,601	-2,666	4,494
metal-i	5,714	1,721	3,320	0,003	2,134	9,294
metal-c	0,000					

When looking at the random effect coefficients, we can see that all coefficients are not significant and thus conclude that the treated ingot has no effect on the model.

Random effects coefficients:							
Source	Value	Standard error	DF	t	Pr > |t|	Lower bound (95%)	Upper bound (95%
ingot-1	-1,558	1,978	12	-0,788	0,446	-5,671	2,555
ingot-2	-3,709	1,978	12	-1,875	0,085	-7,821	0,404
ingot-3	4,074	1,978	12	2,060	0,062	-0,039	8,187
ingot-4	0,234	1,978	12	0,118	0,908	-3,879	4,347
ingot-5	0,849	1,978	12	0,429	0,675	-3,264	4,961
ingot-6	-3,043	1,978	12	-1,539	0,150	-7,156	1,070
ingot-7	3,153	1,978	12	1,594	0,137	-0,960	7,266

Finally, we can say that the bond is the only factor in the model that has a significant effect on the necessary pressure to break the ingot.

Some other output can be useful and are available in XLSTAT like residuals, residuals charts...