Running MLwiN from within Stata: the `runmlwin` command

Research Workshop in Multilevel Modelling using MLwiN
Bristol
13th September 2013

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Centre for Multilevel Modelling
University of Bristol
What is runmlwin?

- runmlwin is a Stata command to run MLwiN seamlessly from within Stata
  - MLwiN offers fast estimation for a wide range of multilevel models, but has limited data management, graphics and programming facilities
  - Stata offers a limited range of multilevel models, but has excellent facilities for pre- and post-estimation data management and graphics and many model testing and interpretation routines
  - runmlwin capitalises on the best features of both packages

- But what if you use R rather than Stata...
  - Then use the r2mlwin R function to run MLwiN from within R
  - r2mlwin provides all the same functionality as runmlwin
1. EXAMPLE ANALYSES USING THE HEDONISM IN EUROPE DATA
Statistics/Data Analysis

MP - Parallel Edition

Copyright 1985-2011 StataCorp LP
StataCorp
4905 Lakeway Drive
College Station, Texas 77845 USA
800-STATA-PC http://www.stata.com
979-696-4600 stata@stata.com
979-696-4601 (fax)

2-user 2-core Stata network perpetual license:
Serial number: 50120527735
Licensed to: ZoneA
          University of Bristol

Notes:
1. (/v# option or set maxvar-) 5000 maximum variables

running C:\Program Files (x86)\Stata12\sysprofile.do ...

running C:\Users\gl9158\profile.do ...
There are no items to show.

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Notes:
1. (/v# option or -set maxvar-) 5000 maximum variables

running C:\Program Files (x86)\Stata12\sysprofile.do ...

running C:\Users\gl9158\profile.do ...

use http://www.bristol.ac.uk/cmm/media/runmlwin/hedonism, clear
use http://www.bristol.ac.uk/cmm/media/runmlwin/hedonism.dta

Notes:
1. (/v# option or -set maxvar-) 5000 maximum variables

running C:\Program Files (x86)\Stata12\sysprofile.do ...

running C:\Users\gl19158\profile.do ...

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2. Use http://www.bristol.ac.uk/cmm/media/runmlwin/hedonism, clear

3. Use codebook, compact
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Notes:
1. (/v# option or -set maxvar-) 5000 maximum variables

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running C:\Users\gl9158\profile.do ...

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. codebook, compact

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Unique</th>
<th>Mean</th>
<th>Min</th>
<th>Max</th>
<th>Label</th>
</tr>
</thead>
<tbody>
<tr>
<td>country</td>
<td>36527</td>
<td>20</td>
<td>10.88318</td>
<td>1</td>
<td>22</td>
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<td>36527</td>
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<td>36527</td>
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<td>-2035884</td>
<td>-4.158</td>
<td>3.25</td>
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<tr>
<td>cons</td>
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<td>1</td>
<td>1</td>
<td>Constant</td>
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<td>Country code</td>
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. codebook, compact
use http://www.bristol.ac.uk/cmm/media/runmlwin/hedonism, clear

codebook, compact

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<td>-4.158</td>
<td>3.25</td>
<td>Hedonism score</td>
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<tr>
<td>cons</td>
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<td>1</td>
<td>1</td>
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<td>10.88318</td>
<td>1</td>
<td>22</td>
<td>Country code</td>
</tr>
</tbody>
</table>
Two-level variance components model

\[
\text{hedonism}_{ij} = \beta_0 + u_j + e_{ij}
\]

\[
u_j \sim N(0, \sigma_u^2)
\]

\[
e_{ij} \sim N(0, \sigma_e^2)
\]

. runmlwin hedonism cons,

    level2(country: cons) ///

    level1(individual: cons)
runmlwin hedonism cons, level2(country: cons) level1(individual: cons)
. runmlwin hedonism cons, level2(country: cons) level1(individual: cons)

MLwiN
Version 2.25

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University of Bristol

Software authors:
Jon Rasbash
and
William Browne
Michael Healy
Bruce Cameron
Christopher Charlton

February 2012
We are grateful to the ESRC for their sustained support.
hedonism_{ij} \sim N(XB, \Omega)

hedonism_{ij} = \beta_{0ij} \cdot \text{cons}

\beta_{0ij} = \beta_0 + u_{0j} + e_{0ij}

\begin{bmatrix} u_{0j} \\ e_{0ij} \end{bmatrix} \sim N(0, \Omega_u) : \Omega_u = \begin{bmatrix} \sigma_{u0}^2 \\ \sigma_{e0}^2 \end{bmatrix}

(36527 of 36527 cases in use)
hedonism_{ij} \sim N(XB, \Omega)

hedonism_{ij} = \beta_{0ij} \text{cons}

\beta_{0ij} = -0.203(0.067) + u_{0j} + e_{0ij}

\begin{bmatrix} u_{0j} \end{bmatrix} \sim N(0, \Omega_u) : \Omega_u = \begin{bmatrix} 0.090(0.029) \end{bmatrix}

\begin{bmatrix} e_{0ij} \end{bmatrix} \sim N(0, \Omega_e) : \Omega_e = \begin{bmatrix} 0.885(0.007) \end{bmatrix}

-2*\text{loglikelihood}(IGLS Deviance) = 99303.351 (36527 of 36527 cases in use)
runmlwin hedonism cons, level2(country: cons) level1(individual: cons)
MLwiN 2.28 multilevel model
Normal response model
Estimation algorithm: IGLS

Number of obs = 36527

<table>
<thead>
<tr>
<th>Level Variable</th>
<th>No. of Groups</th>
<th>Observations per Group</th>
<th>Minimum</th>
<th>Average</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>country</td>
<td>20</td>
<td>1213</td>
<td>1826.3</td>
<td>2785</td>
<td></td>
</tr>
</tbody>
</table>

Run time (seconds) = 41.94
Number of iterations = 3
Log likelihood = -49651.676
Deviance = 99303.352

hedonism      Coef.     Std. Err.   z      P>|z|     [95% Conf. Interval]
cons         -.2031523  .0671835  -3.02  0.002  -.3348295  -.0714752

Random-effects Parameters

<table>
<thead>
<tr>
<th>Level 2: country</th>
<th>Estimate</th>
<th>Std. Err.</th>
<th>[95% Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>var(cons)</td>
<td>.0897654</td>
<td>.0285461</td>
<td>.0338161  .1457147</td>
</tr>
</tbody>
</table>
Refit the model by RIGLS and retrieve the level-2 residuals

\[ \text{hedonism}_{ij} = \beta_0 + u_j + e_{ij} \]

\[ u_j \sim N(0, \sigma_u^2) \]

\[ e_{ij} \sim N(0, \sigma_e^2) \]

. runmlwin hedonism cons, ///

   level2(country: cons, residuals(u)) ///

   level1(individual: cons) ///

   rigls nogroup nopause
. runmlwin hedonism cons, level2(country: cons, residuals(u)) level1(individual: > cons) rigls nogroup nopause

MLwiN 2.28 multilevel model
Number of obs = 36527
Normal response model
Estimation algorithm: RIGLS
Run time (seconds) = 2.77
Number of iterations = 3
Log restricted-likelihood = -49651.688
Restricted-deviance = 99303.375

| hedonism | Coef.  | Std. Err. | z     | P>|z| | [95% Conf. Interval] |
|----------|--------|-----------|-------|------|---------------------|
| cons     | -0.2031516 | 0.0689179 | -2.95 | 0.003 | -0.3382282 to -0.0680751 |

Random-effects Parameters

<table>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Level 2: country</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>var(cons)</td>
<td>0.0944864</td>
<td>0.0298413</td>
<td>0.0359985 to 0.1529742</td>
</tr>
<tr>
<td>Level 1: individual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>var(cons)</td>
<td>0.8850616</td>
<td>0.0065509</td>
<td>0.8722221 to 0.8979011</td>
</tr>
</tbody>
</table>
VPC = ICC = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_e^2}

| Variable   | Coef.   | Std. Err. | z     | P>|z| | [95% Conf. Interval] |
|------------|---------|-----------|-------|------|----------------------|
| cons       | -.2031516 | .0689179 | -2.95 | 0.003 | -.3382282 -.0680751 |

Random-effects Parameters

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<td>.0065509</td>
<td>.8722221 .8979011</td>
</tr>
</tbody>
</table>

\[
\text{VPC} = \text{ICC} = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_e^2}
\]

\[
. \text{display} \ 0.094/(0.094 + 0.885) \\
0.09601634
\]

\[
. \text{display} \ [\text{RP2}]\text{var(cons)}/([\text{RP2}]\text{var(cons)} + [\text{RP1}]\text{var(cons)}) \\
0.09645915
\]
H_0: \sigma^2_u = 0; H_1: \sigma^2_u > 0; \chi^2_1 = 3286, p < 0.01
Caterpillar plot showing country residuals with 95% CIs

\[ \hat{u}_j \pm 1.96 \times \text{SE}(\hat{u}_j) \]

```
. keep country countrycode u0 u0se
. duplicates drop
. isid country
. sort u0
. generate u0rank = _n
. serrbar u0 u0se u0rank, scale(1.96) yline(0)
```
Caterpillar plot showing country residuals with 95% CIs

```plaintext
. serrbar u0 u0se u0rank, scale(1.96)
> mvopts(mlabel(countrycode)
> mlabposition(6) mlabgap(huge))
> ytitle("Residual") yline(0) xtitle("Country (ranked)")
```
Two-level random-intercept model with covariates

hedonism_{ij} = \beta_0 + \beta_1 \text{age46}_{ij} + u_j + e_{ij}

u_j \sim N(0, \sigma_u^2)

e_{ij} \sim N(0, \sigma_e^2)

. generate age46 = age - 46

. runmlwin hedonism cons age46, ///
  level2(country: cons, residuals(u)) ///
  level1(individual: cons) ///
  rigls noheader nopause
. generate age46 = age - 46
(163 missing values generated)

. runmlwin hedonism cons age46, level2(country: cons, residuals(u)) level1(individ
> ual: cons) rigls nogroup nopause

MLwiN 2.28 multilevel model
Normal response model
Estimation algorithm: RIGLS
Run time (seconds) = 3.46
Number of iterations = 3
Log restricted-likelihood = -47294.555
Restricted-deviance = 94589.109

| hedonism | Coef. | Std. Err. | z     | P>|z| | 95% Conf. Interval |
|----------|-------|-----------|-------|------|-------------------|
| cons     | -0.198907 | 0.0687597 | -2.89 | 0.004 | (-0.3336736, -0.0641404) |
| age46    | -0.0174069 | 0.0002581 | -67.45 | 0.000 | (-0.0179127, -0.0169011) |

Random-effects Parameters

<table>
<thead>
<tr>
<th>Level 2: country</th>
<th>Estimate</th>
<th>Std. Err.</th>
<th>95% Conf. Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>var(cons)</td>
<td>0.094105</td>
<td>0.0297527</td>
<td>0.0357908, 0.1524193</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level 1: individual</th>
<th>Estimate</th>
<th>Std. Err.</th>
<th>95% Conf. Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>var(cons)</td>
<td>0.7869442</td>
<td>0.0058377</td>
<td>0.7755025, 0.7983859</td>
</tr>
</tbody>
</table>
. predict predxb
. generate predxbu = predxb + u0
. sort country age46
. twoway (line predxbu age, connect(ascending)),
> ytitle("Predicted hedonism")
> xtitle("Age (in years)") xline(46)
Two-level random-slope model

\[ \text{hedonism}_{ij} = \beta_0 + \beta_1 \text{age46}_{ij} + u_{0j} + u_{1j}\text{age46}_{ij} + e_{ij} \]

\[ (u_{0j}) \sim N\left(0, \begin{pmatrix} \sigma_{u0}^2 \\ \sigma_{u1}^2 \end{pmatrix}\right) \]

\[ e_{ij} \sim N(0, \sigma_e^2) \]

. runmlwin hedonism cons age46, ///

level2(country: cons age46, residuals(u)) ///

level1(individual: cons) ///

rigls noheader nopause
. runmlwin hedonism cons age46, level2(country: cons age46, residuals(u)) level1(individual: cons)rigls noheader nopause

|         | Coef.  | Std. Err. | z    | P>|z|   | [95% Conf. Interval] |
|---------|--------|-----------|------|-------|----------------------|
| cons    | -0.1999337 | 0.06904   | -2.90| 0.004 | -0.3352496 to -0.0646177 |
| age46   | -0.0176279 | 0.0010115 | -17.43| 0.000 | -0.0196104 to -0.0156453 |

Random-effects Parameters

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</thead>
<tbody>
<tr>
<td>Level 2: country</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>var(cons)</td>
<td>0.0948761</td>
<td>0.0301369</td>
<td>0.035809 to 0.1539433</td>
</tr>
<tr>
<td>cov(cons, age46)</td>
<td>0.0009578</td>
<td>0.0003784</td>
<td>0.0002161 to 0.0016995</td>
</tr>
<tr>
<td>var(age46)</td>
<td>0.0000191</td>
<td>0.0000607</td>
<td>0.0000183 to 0.0000398</td>
</tr>
<tr>
<td>Level 1: individual</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>var(cons)</td>
<td>0.7810343</td>
<td>0.0057955</td>
<td>0.7696754 to 0.7923932</td>
</tr>
</tbody>
</table>

. estimates store RS

. lrtest RI RS

Likelihood-ratio test
(Assumption: RI nested in RS)

LR chi2(2) = 232.19
Prob > chi2 = 0.0000
. predict predxb
. generate predxbu = predxb + u0 + u1*age46
. sort country age46
. twoway (line predxbu age, connect(ascending)),
> ytitle("Predicted hedonism") xtitle("Age (in years)")
> xline(46)
. runmlwin, noheader correlations

| Variable    | Coef.    | Std. Err. | z     | P>|z|  | [95% Conf. Interval] |
|-------------|----------|-----------|-------|------|----------------------|
| hedonism    |          |           |       |      |                      |
| cons        | -.1999337| .06904    | -2.90 | 0.004| -.3352496 -.0646177  |
| age46       | -.0176279| .0010115  | -17.43| 0.000| -.0196104 -.0156453  |

Random-effects Parameters

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<tr>
<td>Level 2: country</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>var(cons)</td>
<td>.0948761</td>
<td>.0301369</td>
<td>.035809 .1539433</td>
</tr>
<tr>
<td>corr(cons, age46)</td>
<td>.7117642</td>
<td>.1190144</td>
<td>.4785001 .9450282</td>
</tr>
<tr>
<td>var(age46)</td>
<td>.0000191</td>
<td>6.47e-06</td>
<td>6.41e-06 .0000318</td>
</tr>
<tr>
<td>Level 1: individual</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>var(cons)</td>
<td>.7810343</td>
<td>.0057955</td>
<td>.7696754 .7923932</td>
</tr>
</tbody>
</table>

\[
\rho_{u01} = \frac{\sigma_{u01}}{\sqrt{\sigma_{u0}^2 \sigma_{u1}^2}}
\]
Slope vs. Intercept residuals

keep country countrycode u0 u1
duplicates drop
isid country
twoway (scatter u1 u0, mlabel(countrycode)), > ytitle("Slope residual (u1)") yline(0) > xtitle("Intercept residual (u0)") xline(0)
Between-country variance as a function of age

\[ \text{Var}(u_{0j} + u_{1j} \text{age}_{ij}) = \sigma^2_{u0} + 2\sigma_{u01}\text{age}_{ij} + \sigma^2_{u1}\text{age}^2_{ij} \]

. generate lev2var = [RP2]var(cons) > + 2*[RP2]cov(cons\text{\textbackslash age46})*age46 + [RP2]var(age46)*age46^2
. twoway (line lev2var age, sort), > ytitle("Between-country variance") xline(46)
```
estimates table SL VC RI RS, stats(deviance) b(%4.3f) stfmt(%6.0f) varwidth(15)

<table>
<thead>
<tr>
<th>Variable</th>
<th>SL</th>
<th>VC</th>
<th>RI</th>
<th>RS</th>
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</tr>
<tr>
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<td>-0.203</td>
<td>-0.199</td>
<td>-0.200</td>
</tr>
<tr>
<td>age46</td>
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<tr>
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<tr>
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</tr>
<tr>
<td>var(cons)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>cov(cons\age46)</td>
<td>0.094</td>
<td>0.094</td>
<td>0.095</td>
<td>0.001</td>
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2. RUNNING MLWIN FROM WITHIN STATA MAKES IT EASY TO REPRODUCE AND DOCUMENT ANALYSES
* 1. Example analyses using the Hedonism in Europe data

* Load the hedonism.dta dataset
use http://www.bristol.ac.uk/cmm/media/runmlwin/hedonism, clear

* Describe and summarize all variables in the data
codebook, compact

* Variance-components model

* Reload the data
use http://www.bristol.ac.uk/cmm/media/runmlwin/hedonism, clear

* Fit the variance-components model by IGLS
runmlwin hedonism cons, level2(country: cons) level1(individual: cons)

* Refit the variance-components model by RIGLS and retrieve the level-2 residuals
runmlwin hedonism cons, ///
         level2(country: cons, residuals(u)) ///
         level1(individual: cons) ///
         rigls nogroup nopause

* Calculate the VPC/ICC
display 0.094/(0.094 + 0.885)
3. RESOURCES TO HELP YOU LEARN runmlwin
help runmlwin

Title

runmlwin - Run the MLwiN multilevel modelling software from within Stata

Syntax

runmlwin responses_and_fixed_part, random_part [discrete(discrete_options)]
[mcmc(mcmc_options)] [general_options]

where the syntax of responses_and_fixed_part is one of the following

for univariate continuous, binary, proportion and count response models

depvar indepvars [if] [in]

for univariate ordered and unordered categorical response models

depvar indepvars1 [(indepvars2, contrast(numlist)) ...] [if] [in]

where indepvars1 are those independent variables which appear with separate
coefficients in each of every log-odds contrast, while indepvars2 are those
independent variables which appear with common coefficients for those
log-odds contrasts specified in contrast(numlist). Contrasts can be thought
of as the separate "subequations" or "arms" of a multinomial response model.
These contrasts are indexed 1, 2, ... up to the total number of contrasts.
Examples

IMPORTANT. The following examples will only work on your computer once you have installed MLwiN and once you have told runmlwin what the mlwin.exe file address is. See Remarks on installing runmlwin above for more information.

(a) Continuous response models

Two-level models

Setup

  . use http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial, clear

Two-level random-intercept model, analogous to xtreg (fitted using IGLS) (See Section 2.5 of the MLwiN User Manual)

  . runmlwin normexam cons standlrt, level2(school: cons) level1(student: cons) nopause

Two-level random-intercept and random-slope (coefficient) model (fitted using IGLS) (See Section 4.4 of the MLwiN User Manual)

  . runmlwin normexam cons standlrt, level2 (school: cons standlrt) level1 (student: cons) nopause

Refit the model, where this time we additionally calculate the level 2 residuals (fitted using IGLS) (See Section 4.4 of the MLwiN User Manual)

  . runmlwin normexam cons standlrt, level2 (school: cons standlrt, residuals(u)) level1 (student: cons) nopause

Two-level random-intercept and random-slope (coefficient) model with a complex level
runmlwin: Running MLwiN from within Stata

runmlwin is a Stata command which allows Stata users to run the powerful MLwiN multilevel modelling software from within Stata.

The multilevel models fitted by runmlwin are often considerably faster than those fitted by the Stata’s xtmixed, xtmelogit and xtmepoisson commands. The range of models which can be fitted by runmlwin is also much wider than those commands. runmlwin also allows fast estimation on large data sets for many of the more complex multilevel models available through the user written gllamm command.

MLwiN has the following features:

1. Estimation of multilevel models for continuous, binary, count, ordered categorical and unordered categorical data
2. Fast estimation via classical and Bayesian methods
3. Estimation of multilevel models for cross-classified and multiple membership nonhierarchical data structures
4. Estimation of multilevel multivariate response models, multilevel spatial models, multilevel measurement error models and multilevel multiple imputation models

These details with a screen shot are available on our runmlwin leaflet (pdf, 0.1mb)
Examples using runmlwin

MLwiN User Manual

These do-files and log files replicate the analyses reported in the MLwiN User Manual (PDF, 4.6 mb) Rasbash, J., Steele, F., Browne, W.J. and Goldstein, H. (2012) Centre for Multilevel Modelling, University of Bristol.

Note that we have not created do-files for Chapters 1, 8 or 19 of the manual as no models are fitted in those chapters. We have also not yet created the do-file for Chapter 17.

- 1 Introducing Multilevel Models
- 2 Introduction to Multilevel Modelling (do | log)
- 3 Residuals (do | log)
- 4 Random Intercept and Random Slope Models (do | log)
- 5 Graphical Procedures for Exploring the Model (do | log)
- 6 Contextual Effects (do | log)
- 7 Modelling the Variance as a Function of Explanatory Variables (do | log)
- 8 Getting Started with your Data
- 9 Logistic Models for Binary and Binomial Responses (do | log)
# runmlwin user forum

## Forum rules

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### ANNOUNCEMENTS

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<td>Read the runmlwin journal article for a full introduction</td>
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<td>by GeorgeLeckie</td>
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<td>runmlwin has had 4300+ downloads since Oct 2011</td>
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<td>1413</td>
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<td>Make sure you have latest version of runmlwin: 24/03/2013</td>
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<td>Do-files to replicate entire MLwiN User &amp; MCMC Manuals</td>
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<td>2846</td>
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<td>Welcome to the runmlwin discussion forum</td>
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### TOPICS

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<td>do-files and examples for three level models</td>
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<td>15</td>
<td>by williamjoe</td>
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<td>Cross-classified model with negative binomial distribution</td>
<td>5</td>
<td>273</td>
<td>by GeorgeLeckie</td>
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<td>Mixed-effects, mixed distribution model</td>
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<td>Getting MCMC residuals and their chains from RS model</td>
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<td>by ChrisCharlton</td>
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<td>Testing the proportional odds assumption in runmlwin</td>
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<td>85</td>
<td>by Eagg1986</td>
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