Running MLwiN from within Stata: the `runmlwin` command

CCSR/ISC Seminar series
Manchester
25th September 2012

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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 of 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 (see later)
  - `R2MLwiN` provides all the same functionality as `runmlwin`

Multilevel modelling in Stata

- Stata provide the `xtmixed`, `xtmelogit` and `xtmepoisson` commands
  - Limited range of models can be specified
  - Computationally quite slow

- Sophia Rabe-Hesketh and colleagues have developed the `gllamm` command
  - Wide range of models can be specified
  - Computationally very slow

- Other user-written multilevel modelling commands available in Stata include: `hlm`, `realcomimpute`, `runmplus`, `sabrestata`, `winbugs`

Multilevel modelling in MLwiN

1. Estimation of multilevel models for continuous, binary, ordered categorical, unordered categorical and count data

2. Fast estimation via classical and Bayesian methods

3. Estimation of multilevel models for cross-classified and multiple membership non-hierarchical data structures

4. Estimation of multilevel multivariate response models, multilevel spatial models, multilevel measurement error models, multilevel multiple imputation models and multilevel factor models

5. Free to UK academics, thanks to ESRC funding

Outline

1. Continuous response models
2. Working efficiently
3. Binary response models
4. Simulation studies
5. MCMC estimation
6. Export models to WinBUGS
7. Speed comparisons
8. More complex analyses
9. Resources to help you learn `runmlwin`
10. Running MLwiN from within R: the `R2MLwiN` function

1. CONTINUOUS RESPONSE MODELS

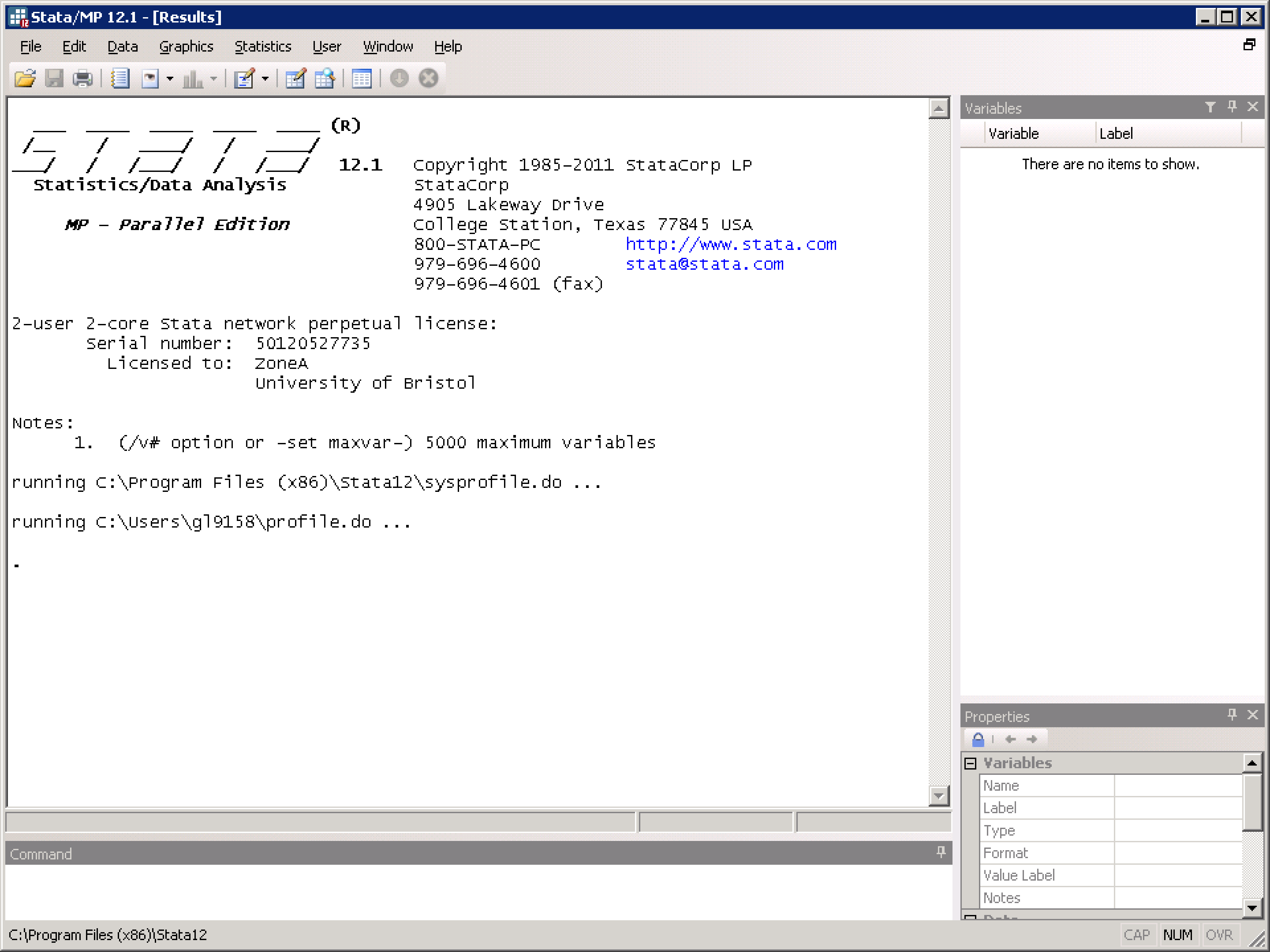
Two-level variance components model

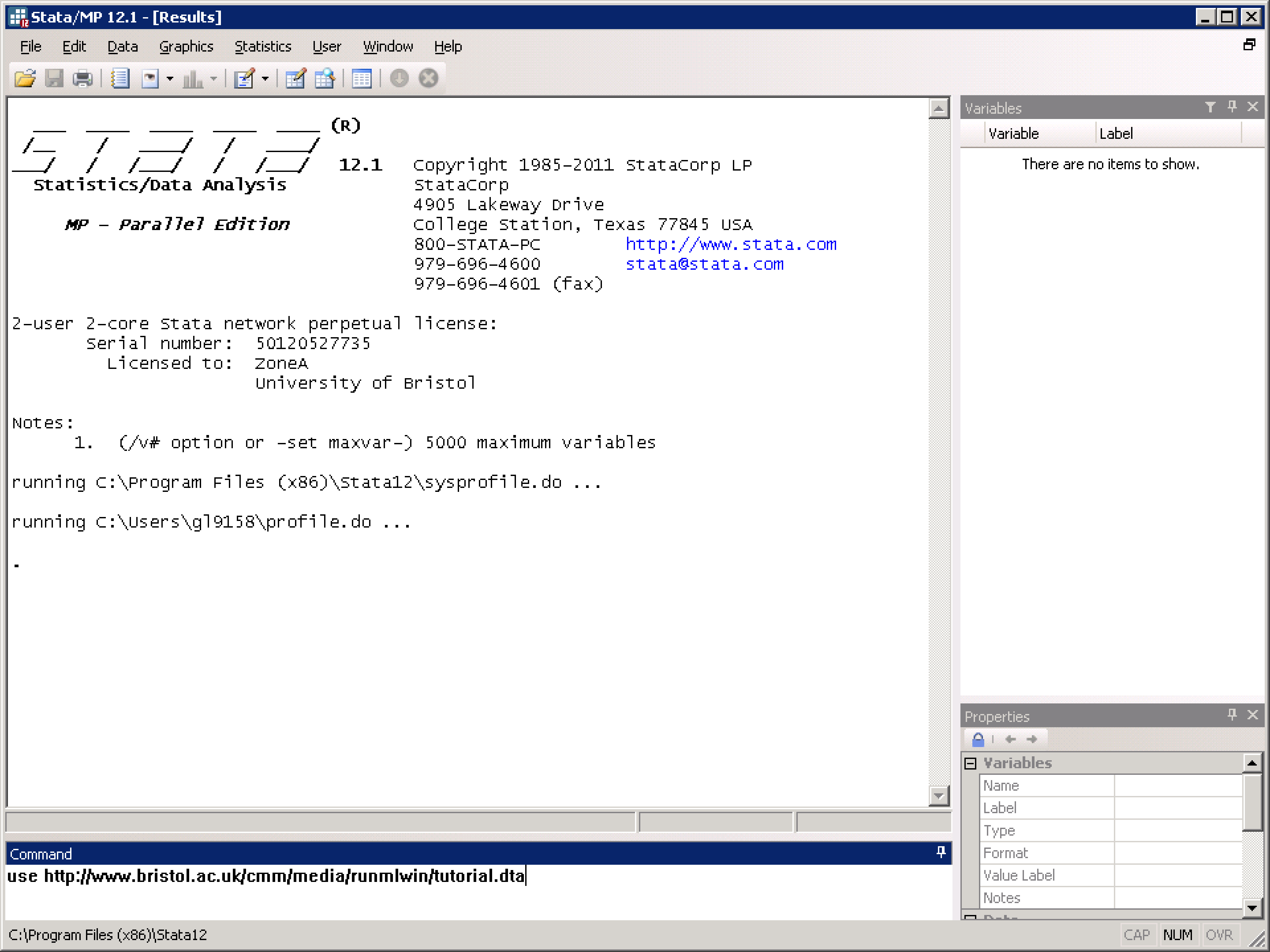
- Inner-London schools exam scores data set
- Main MLwiN User Manual example (the ‘tutorial’ data set)
- 4059 students nested within 65 schools

$$\mathbf{normexam}_{ij} = \beta_0 + u_j + e_{ij}$$

$$u_j \sim \mathrm{N}(0, \sigma_u^2)$$

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


Stata/MP 12.1 - [Results]
File Edit Data Graphics Statistics User Window Help
(R)
12.1 Copyright 1985-2011 StataCorp LP
Statistics/Data Analysis StataCorp
4905 Lakeway Drive
MP - Parallel Edition 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 ...
.
Variables
Variable
Label
There are no items to show.
Properties
Variables
Name
Label
Type
Format
Value Label
Notes
Command
C:\Program Files (x86)\Stata12
CAP
NUM
OVR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use http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta
C:\Program Files (x86)\Stata12
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NUM
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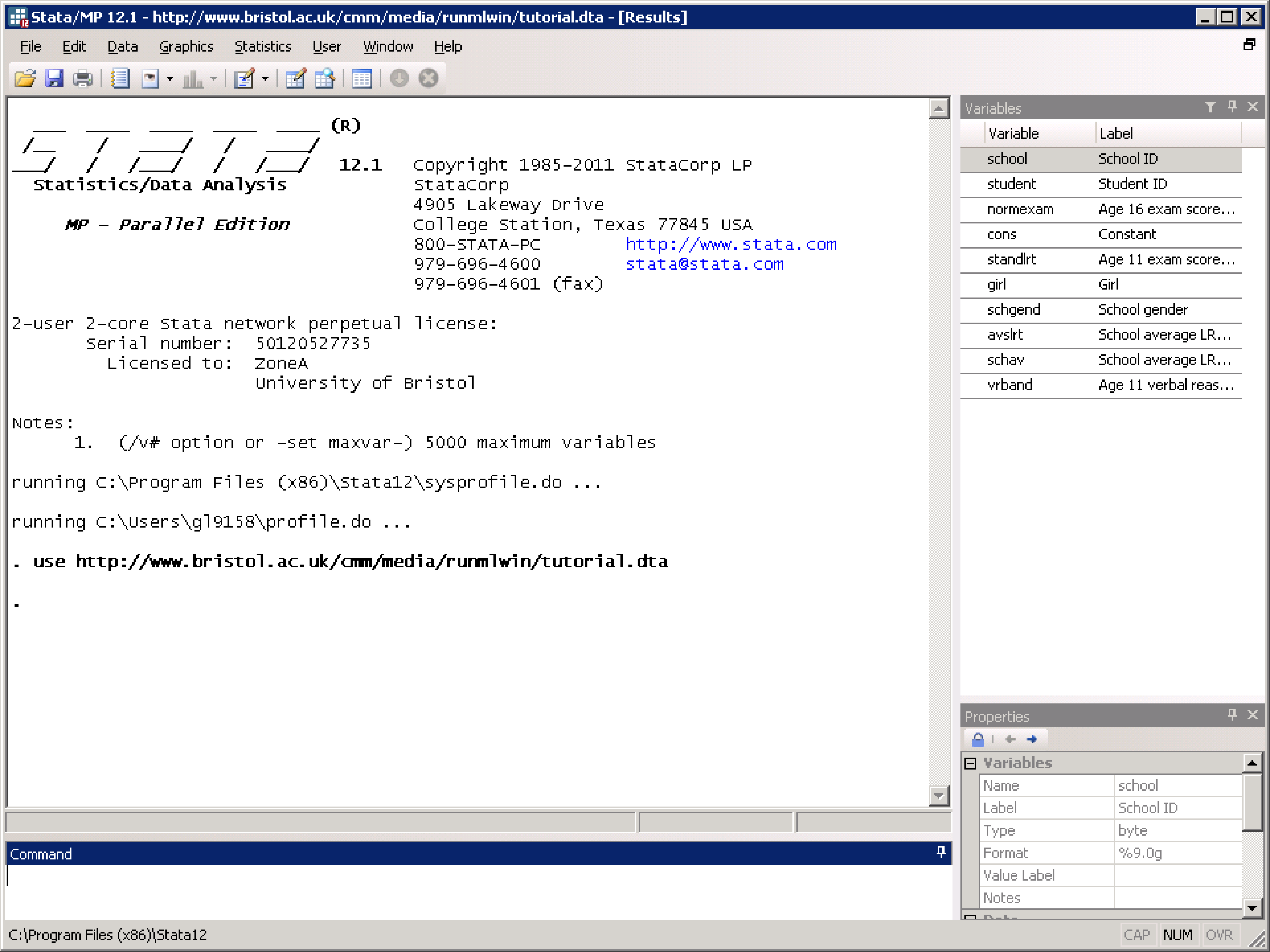
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.
Variables
Variable Label
school School ID
student Student ID
normexam Age 16 exam score...
cons Constant
standlrt Age 11 exam score...
girl Girl
schgend School gender
avslrt School average LR...
schav School average LR...
vrband Age 11 verbal reas...
Properties
Variables
Name school
Label School ID
Type byte
Format %9.0g
Value Label
Notes
Command
C:\Program Files (x86)\Stata12
CAP NUM OVR

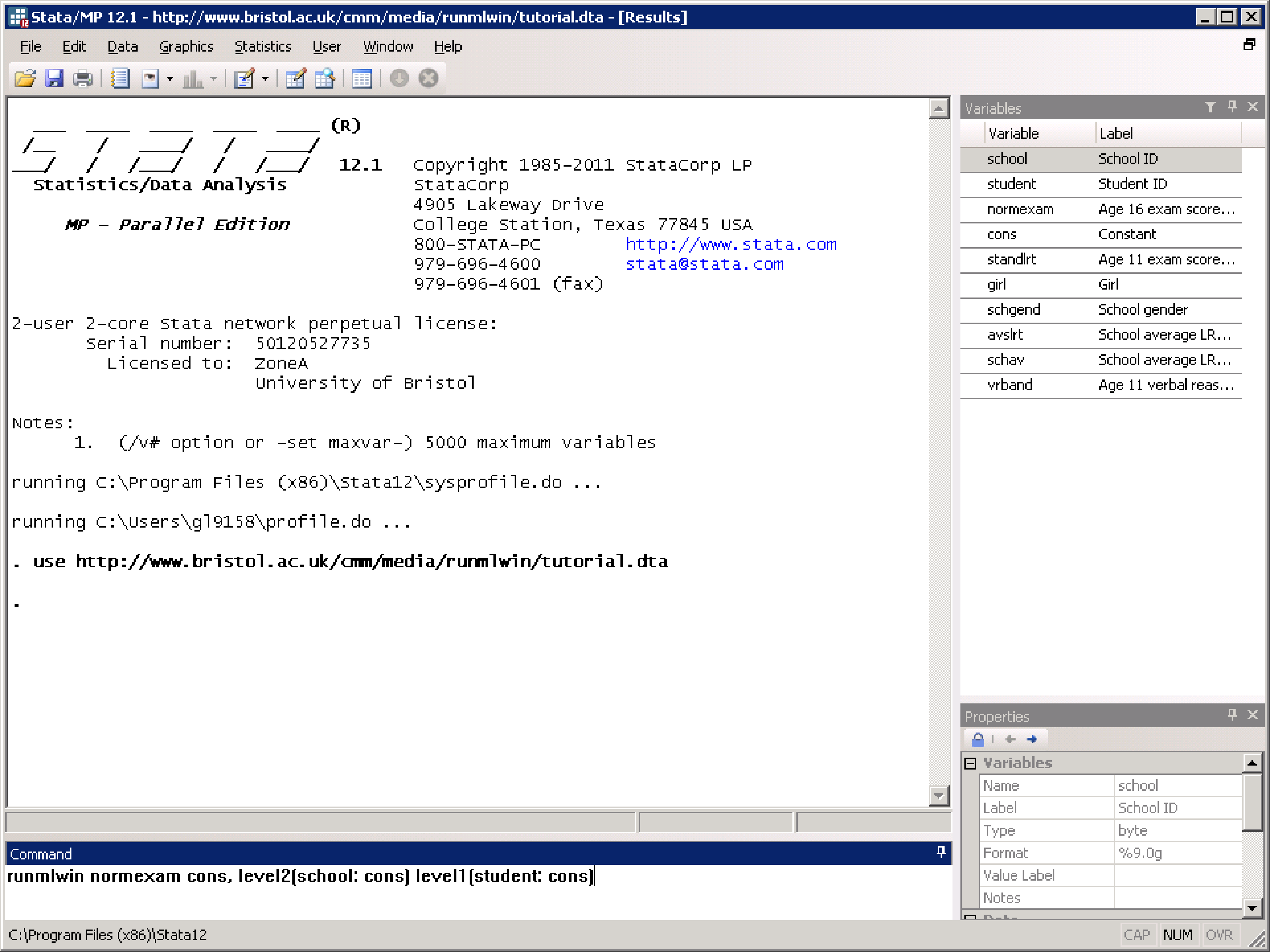
The `runmlwin` command syntax

$$\textbf{normexam}_{ij} = \beta_0 + u_j + e_{ij}$$

$$u_j \sim \mathrm{N}(0, \sigma_u^2)$$

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

```
. runmlwin normexam cons, ///
      level2(school: cons) ///
      level1(student: cons)
```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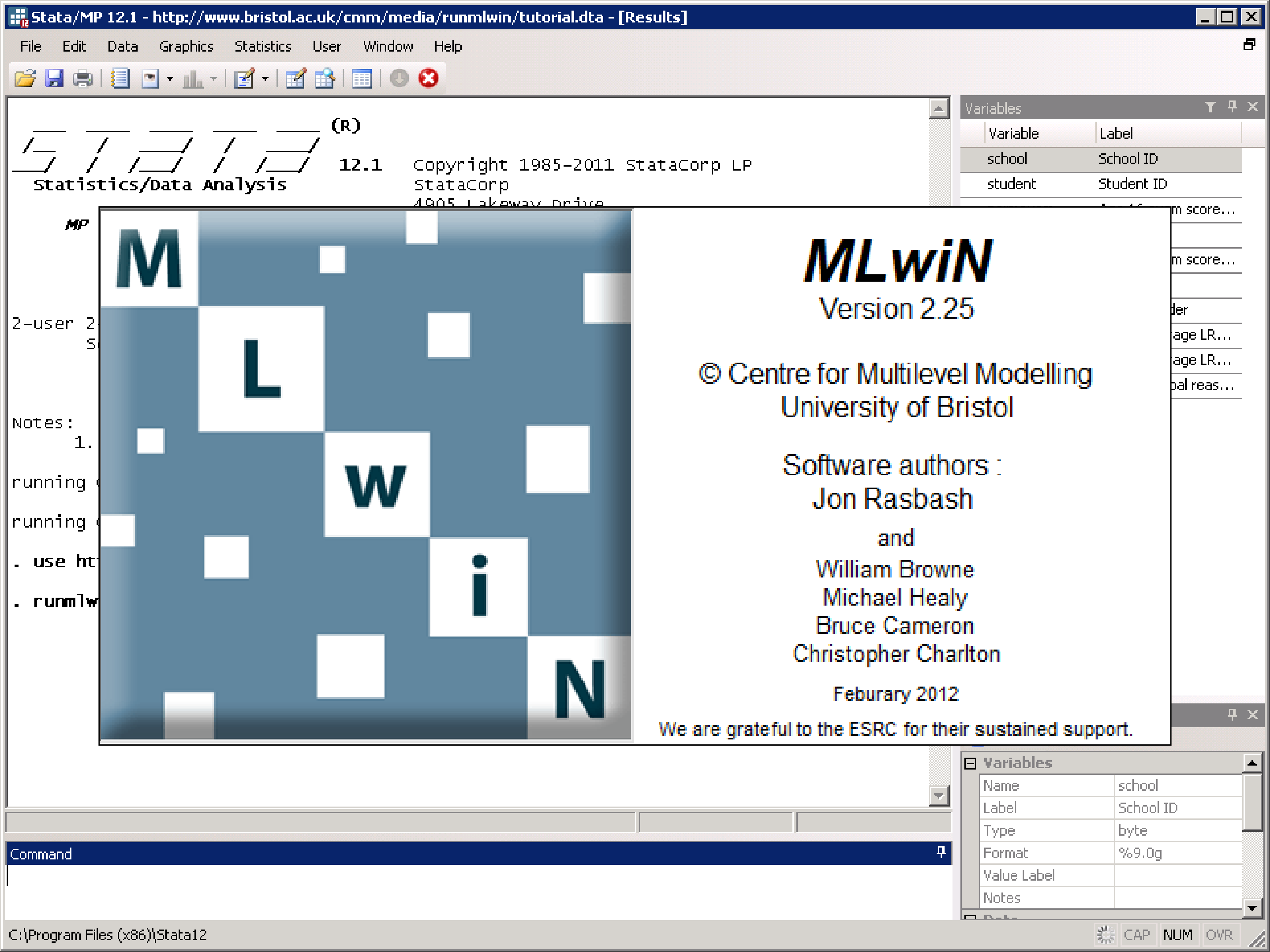
C:\Program Files (x86)\Stata12
CAP NUM OVR


Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]
File Edit Data Graphics Statistics User Window Help
(R)
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Statistics/Data Analysis
StataCorp
MP
2-user 2
Notes:
1.
running
running
. use ht
. runmlw
MLwiN
Version 2.25
© Centre for Multilevel Modelling
University of Bristol
Software authors :
Jon Rasbash
and
William Browne
Michael Healy
Bruce Cameron
Christopher Charlton
Feburary 2012
We are grateful to the ESRC for their sustained support.
Variables
Variable
Label
school
School ID
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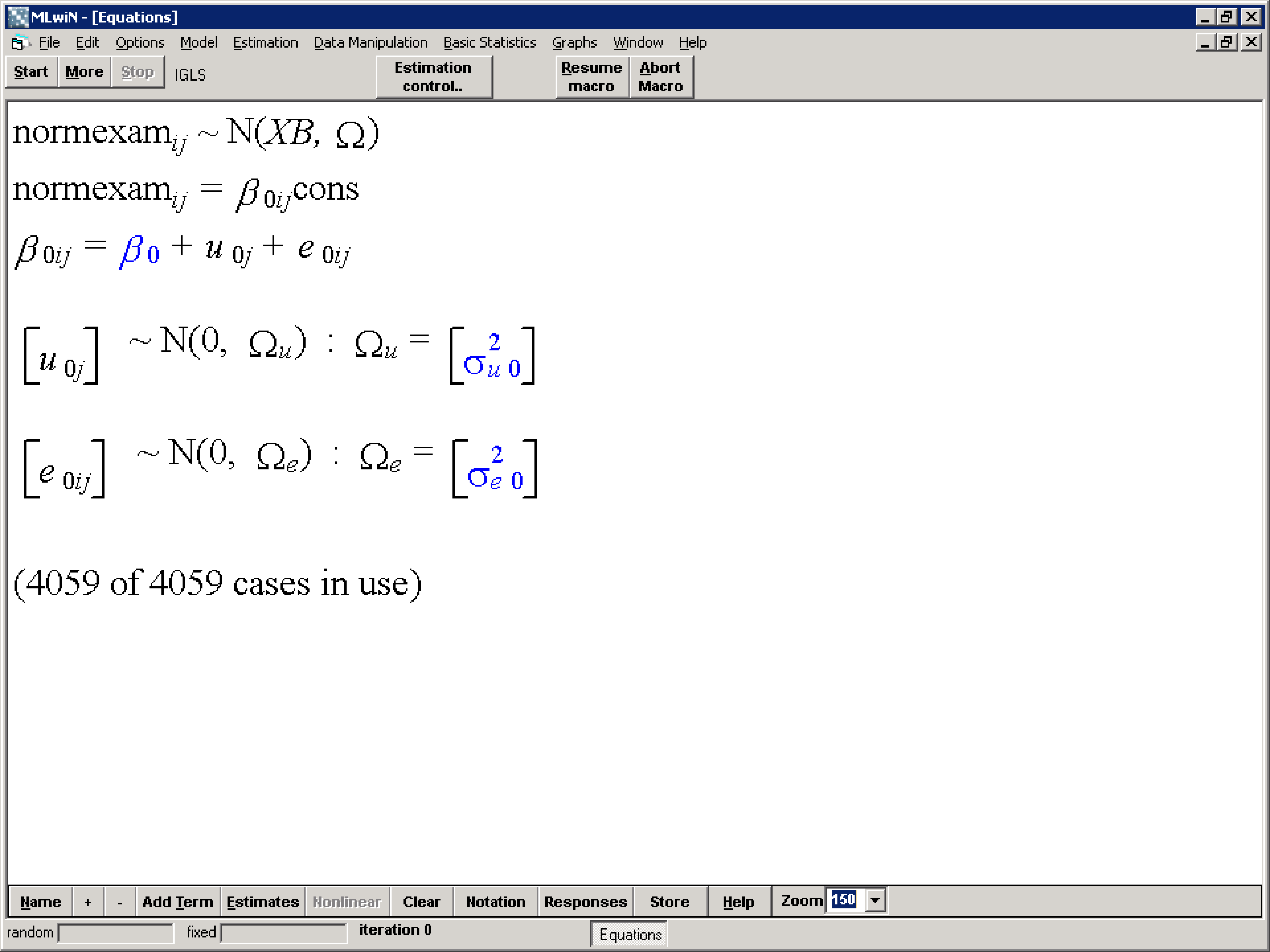
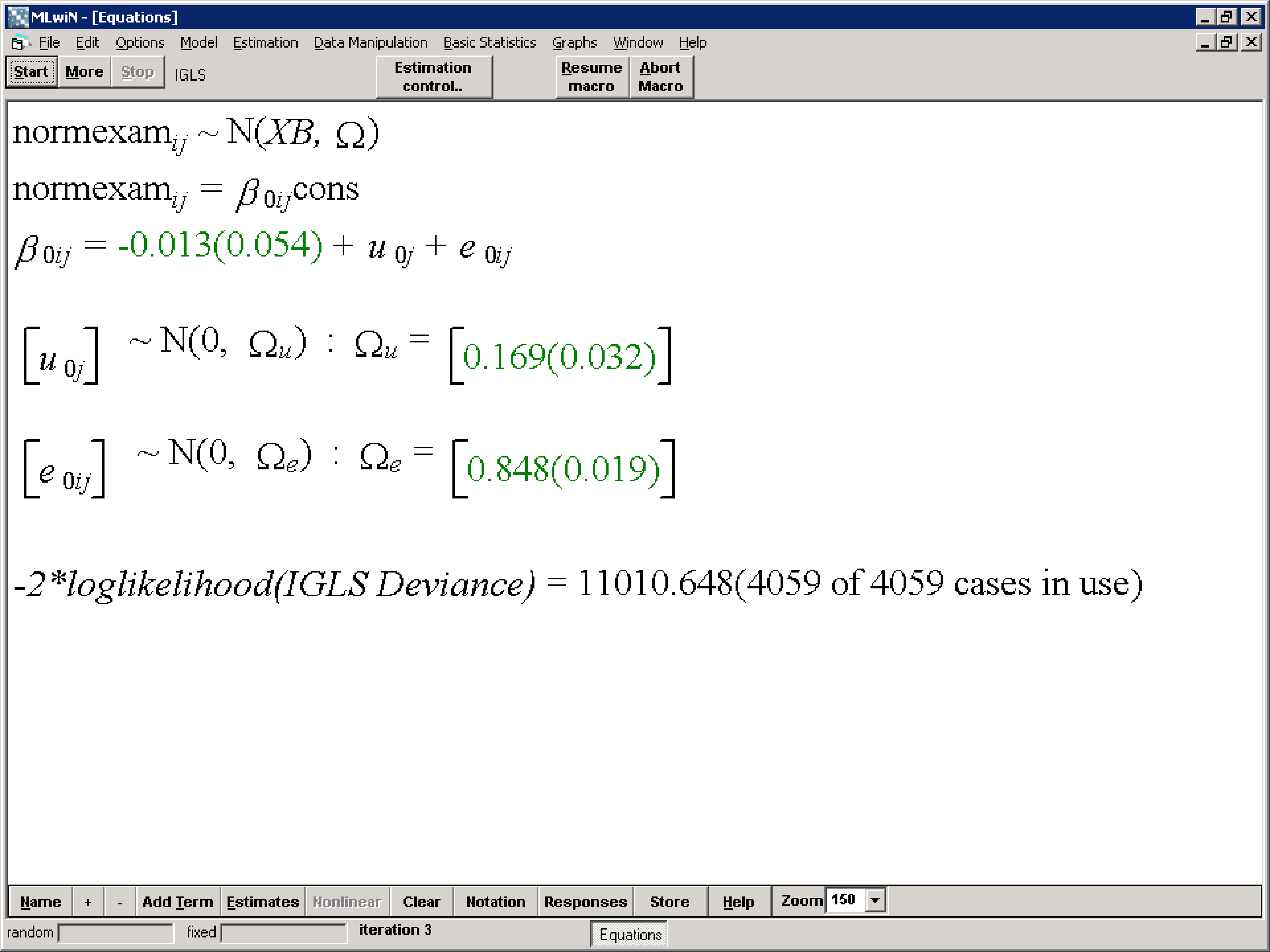
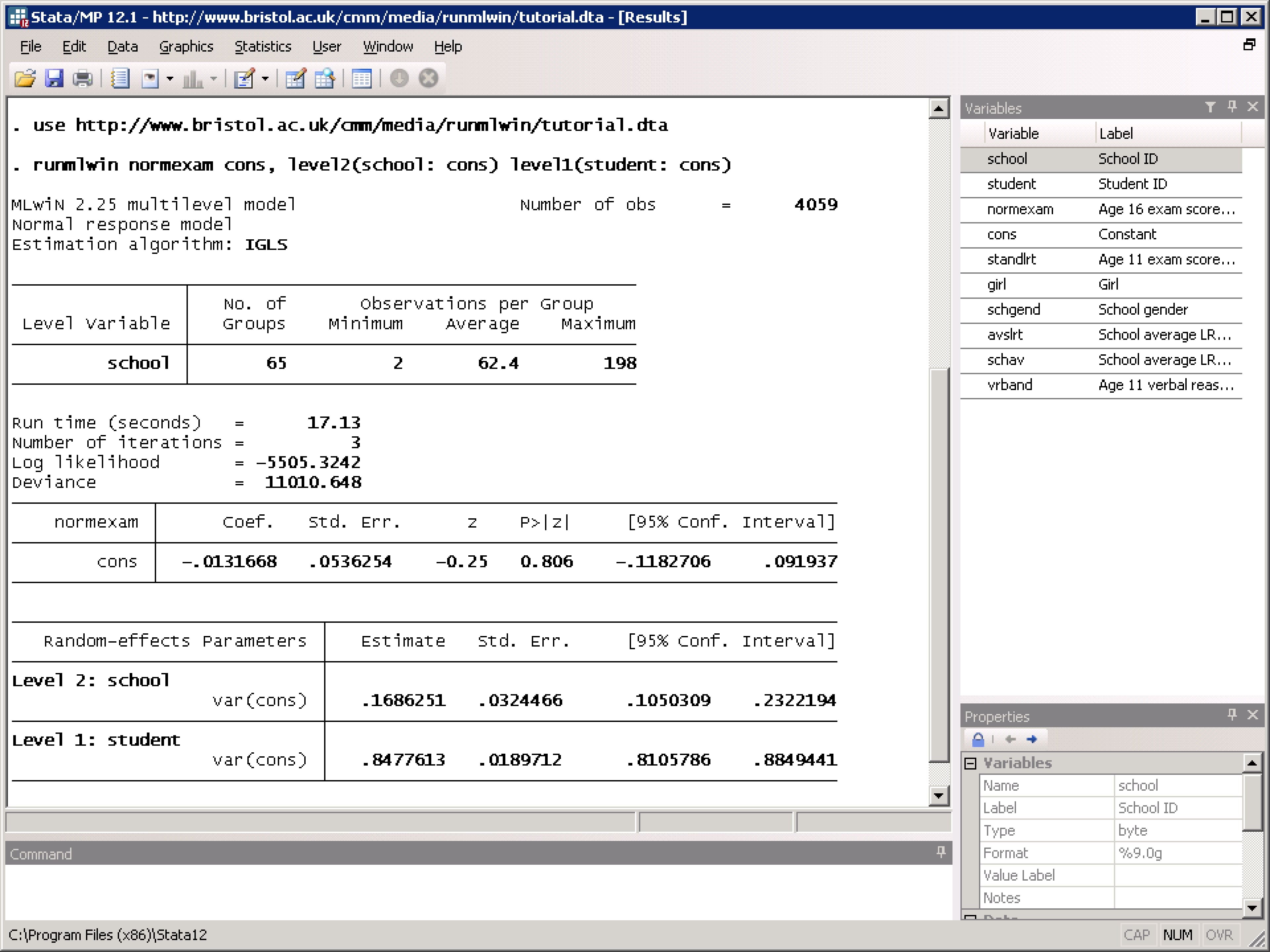

MLwiN - [Equations]
File Edit Options Model Estimation Data Manipulation Basic Statistics Graphs Window Help
Start More Stop IGLS
Estimation control..
Resume macro
Abort Macro
$\text{normexam}_{ij} \sim \mathrm{N}(XB, \Omega)$
$\text{normexam}_{ij} = \beta_{0ij}\text{cons}$
$\beta_{0ij} = \beta_0 + u_{0j} + e_{0ij}$
$\begin{bmatrix} u_{0j} \end{bmatrix} \sim \mathrm{N}(0, \Omega_u) : \Omega_u = \begin{bmatrix} \sigma^2_{u0} \end{bmatrix}$
$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim \mathrm{N}(0, \Omega_e) : \Omega_e = \begin{bmatrix} \sigma^2_{e0} \end{bmatrix}$
(4059 of 4059 cases in use)
Name + - Add Term Estimates Nonlinear Clear Notation Responses Store Help Zoom 150
random fixed iteration 0
Equations


MLwiN - [Equations]
File Edit Options Model Estimation Data Manipulation Basic Statistics Graphs Window Help
Start More Stop IGLS
Estimation control..
Resume macro
Abort Macro
$\text{normexam}_{ij} \sim \mathrm{N}(XB, \Omega)$
$\text{normexam}_{ij} = \beta_{0ij}\text{cons}$
$\beta_{0ij} = -0.013(0.054) + u_{0j} + e_{0ij}$
$\left[u_{0j}\right] \sim \mathrm{N}(0, \Omega_u) : \Omega_u = \left[0.169(0.032)\right]$
$\left[e_{0ij}\right] \sim \mathrm{N}(0, \Omega_e) : \Omega_e = \left[0.848(0.019)\right]$
-2*loglikelihood(IGLS Deviance) = 11010.648(4059 of 4059 cases in use)
Name + - Add Term Estimates Nonlinear Clear Notation Responses Store Help Zoom 150
random fixed iteration 3 Equations




```
. use http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta

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

MLwiN 2.25 multilevel model                    Number of obs      =      4059
Normal response model
Estimation algorithm: IGLS

-----------------------------------------------------------
                 |   No. of       Observations per Group
 Level Variable  |   Groups    Minimum    Average    Maximum
-----------------+-----------------------------------------
          school |       65          2       62.4        198
-----------------------------------------------------------

Run time (seconds)   =       17.13
Number of iterations =           3
Log likelihood       = -5505.3242
Deviance             =  11010.648
------------------------------------------------------------------------------
    normexam |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        cons |  -.0131668   .0536254    -0.25   0.806    -.1182706     .091937
------------------------------------------------------------------------------


------------------------------------------------------------------------------
   Random-effects Parameters |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
Level 2: school              |
                   var(cons) |   .1686251   .0324466      .1050309    .2322194
-----------------------------+------------------------------------------------
Level 1: student             |
                   var(cons) |   .8477613   .0189712      .8105786    .8849441
------------------------------------------------------------------------------
```

Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

File Edit Data Graphics Statistics User Window Help

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

MLwiN 2.25 multilevel model                     Number of obs      =      4059
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        cons |  -.0131668   .0536254    -0.25   0.806    -.1182706     .091937
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-----------------------------+------------------------------------------------
Level 1: student             |
                   var(cons) |   .8477613   .0189712      .8105786    .8849441
------------------------------------------------------------------------------
```

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Add covariates

$$\mathbf{normexam}_{ij} = \beta_0 + \beta_1\mathbf{standlrt}_{ij} + \beta_2\mathbf{girl}_{ij} + u_j + e_{ij}$$

$$u_j \sim \mathrm{N}(0, \sigma_u^2)$$

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

```
. runmlwin normexam cons standlrt girl, ///
      level2(school: cons) ///
      level1(student: cons)
```

Include a random slope

$$\textbf{normexam}_{ij} = \beta_0 + \beta_1\textbf{standlrt}_{ij} + \beta_2\textbf{girl}_{ij} + u_{0j} + u_{1j}\textbf{standlrt}_{ij} + e_{ij}$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim \mathrm{N}\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & \\ \sigma_{u01} & \sigma_{u1}^2 \end{pmatrix}\right\}$$

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

```
. runmlwin normexam cons standlrt girl, ///
      level2(school: cons standlrt) ///
      level1(student: cons)
```

Allow for level 1 heteroskedasticity

$$\mathbf{normexam}_{ij} = \beta_0 + \beta_1\mathbf{standlrt}_{ij} + \beta_2\mathbf{girl}_{ij} + u_{0j} + u_{1j}\mathbf{standlrt}_{ij}$$

$$+e_{2ij}\mathbf{girl}_{ij} + e_{3ij}\mathbf{boy}_{ij}$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim \mathrm{N}\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & \\ \sigma_{u01} & \sigma_{u1}^2 \end{pmatrix}\right\}$$

$$\begin{pmatrix} e_{2ij} \\ e_{3ij} \end{pmatrix} \sim \mathrm{N}\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{e2}^2 & \\ 0 & \sigma_{e3}^2 \end{pmatrix}\right\}$$

```
. generate boy = 1 - girl

. runmlwin normexam cons standlrt girl, ///

      level2(school: cons standlrt) ///

      level1(student: girl boy, diagonal)
```

Retrieve the level 2 residuals

$$\mathbf{normexam}_{ij} = \beta_0 + \beta_1\mathbf{standlrt}_{ij} + \beta_2\mathbf{girl}_{ij} + u_{0j} + u_{1j}\mathbf{standlrt}_{ij}$$

$$+e_{2ij}\mathbf{girl}_{ij} + e_{3ij}\mathbf{boy}_{ij}$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim \mathrm{N}\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & \\ \sigma_{u01} & \sigma_{u1}^2 \end{pmatrix}\right\}$$

$$\begin{pmatrix} e_{2ij} \\ e_{3ij} \end{pmatrix} \sim \mathrm{N}\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{e2}^2 & \\ 0 & \sigma_{e3}^2 \end{pmatrix}\right\}$$

```
. runmlwin normexam cons standlrt girl, ///
      level2(school: cons standlrt, residuals(u)) ///
      level1(student: girl boy, diagonal)
```

Do not pause in MLwiN and do not display the group table in Stata

$$\textbf{normexam}_{ij} = \beta_0 + \beta_1\textbf{standlrt}_{ij} + \beta_2\textbf{girl}_{ij} + u_{0j} + u_{1j}\textbf{standlrt}_{ij}$$

$$+e_{2ij}\textbf{girl}_{ij} + e_{3ij}\textbf{boy}_{ij}$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim \mathrm{N}\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2_{u0} & \\ \sigma_{u01} & \sigma^2_{u1} \end{pmatrix}\right\}$$

$$\begin{pmatrix} e_{2ij} \\ e_{3ij} \end{pmatrix} \sim \mathrm{N}\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2_{e2} & \\ 0 & \sigma^2_{e3} \end{pmatrix}\right\}$$

```
. runmlwin normexam cons standlrt girl, ///
      level2(school: cons standlrt, residuals(u)) ///
      level1(student: girl boy, diagonal) nogroup nopause
```

Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
.
. runmlwin normexam cons standlrt girl, ///
>         level2(school: cons standlrt, residuals(u)) ///
>         level1(student: girl boy, diagonal) ///
>         nogroup nopause

MLwiN 2.25 multilevel model                        Number of obs      =      4059
Normal response model
Estimation algorithm: IGLS
Run time (seconds)     =       1.84
Number of iterations   =          4
Log likelihood         =   -4640.71
Deviance               =  9281.4199

------------------------------------------------------------------------------
    normexam |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        cons |   -.111534   .0433072    -2.58   0.010    -.1964145   -.0266536
    standlrt |   .5529361   .0200758    27.54   0.000     .5135882    .5922841
        girl |   .1752785   .0324156     5.41   0.000     .1117451     .238812
------------------------------------------------------------------------------


------------------------------------------------------------------------------
   Random-effects Parameters |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
Level 2: school              |
                   var(cons) |   .0862511    .017175      .0525887    .1199135
           cov(cons,standlrt)|   .0190537   .0066789      .0059632    .0321441
               var(standlrt) |   .0148919   .0044702      .0061304    .0236534
-----------------------------+------------------------------------------------
Level 1: student             |
                   var(girl) |   .5251641   .0152836      .4952088    .5551194
                    var(boy) |   .5874345   .0209983      .5462786    .6285904
------------------------------------------------------------------------------
```

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Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
.
. runmlwin normexam cons standlrt girl, ///
>         level2(school: cons standlrt, residuals(u)) ///
>         level1(student: girl boy, diagonal) ///
>         nogroup nopause

MLwiN 2.25 multilevel model                    Number of obs      =      4059
Normal response model
Estimation algorithm: IGLS
Run time (seconds)    =      1.84
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------------------------------------------------------------------------------
    normexam |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        cons |   -.111534   .0433072    -2.58   0.010    -.1964145   -.0266536
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          cov(cons,standlrt) |   .0190537   .0066789      .0059632    .0321441
               var(standlrt) |   .0148919   .0044702      .0061304    .0236534
-----------------------------+------------------------------------------------
Level 1: student             |
                   var(girl) |   .5251641   .0152836      .4952088    .5551194
                    var(boy) |   .5874345   .0209983      .5462786    .6285904
------------------------------------------------------------------------------
```
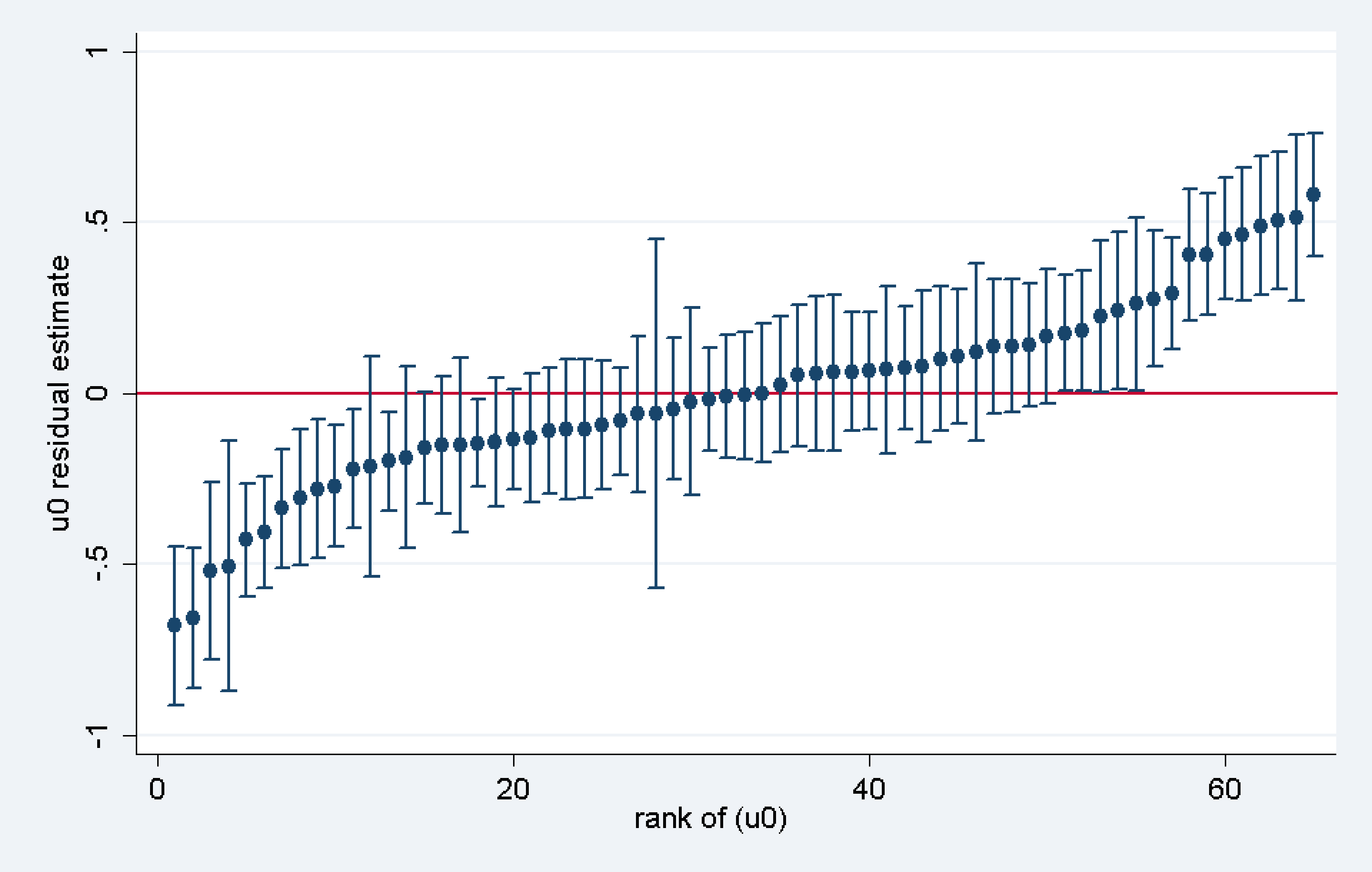

Variables

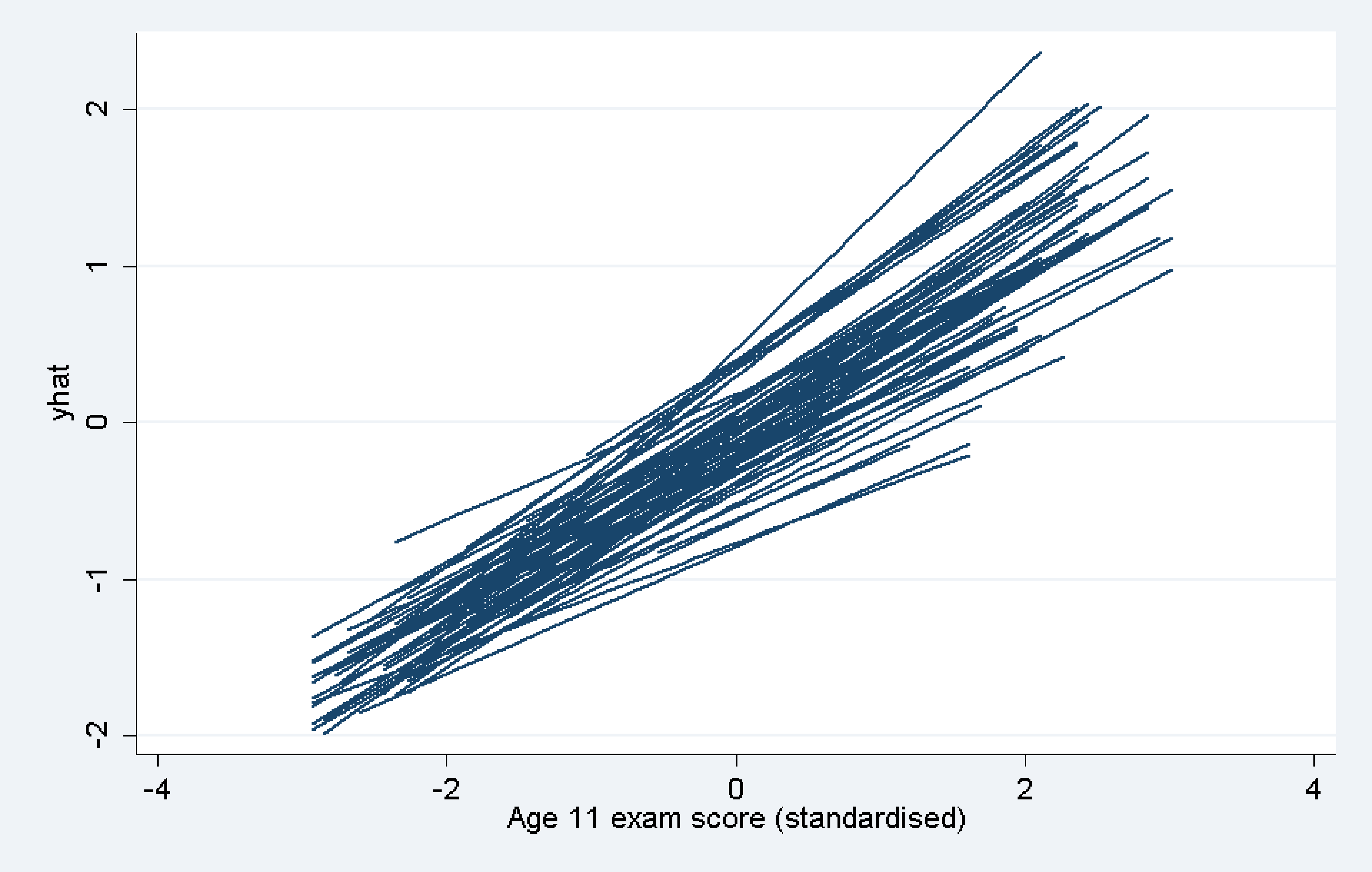
Variable
school
student
normexam
cons
standlrt
girl
schgend
avslrt
schav
vrband
boy
u0
u1
u0se
u1se

C:\Program Files (x86)\Stata12

CAP NUM OVR




```
. bysort school: keep if _n==1
. egen u0rank = rank(u0)
. serrbar u0 u0se u0rank, scale(1.96) yline(0)
```




```
. gen yhat = [FP1]cons + [FP1]stand*stand + u0 + u1*stand
. sort school standlrt
. line yhat standlrt, connect(ascending)
```

Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

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```
. lrtest model1 model2

Likelihood-ratio test                                 LR chi2(5)  =   1729.23
(Assumption: model1 nested in model2)                 Prob > chi2 =    0.0000

.
.
.
.
.
. test [RP1]var(girl) = [RP1]var(boy)

 ( 1)  [RP1]var(girl) - [RP1]var(boy) = 0

           chi2(  1) =    5.74
         Prob > chi2 =    0.0166

.
.
.
.
.
. nlcom (Boy_VPC_xis0: [RP2]var(cons)/([RP2]var(cons) + [RP1]var(boy)))

Boy_VPC_xis0:  [RP2]var(cons)/([RP2]var(cons) + [RP1]var(boy))
```

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Boy_VPC_xis0	.1280287	.0226244	5.66	0.000	.0836856	.1723718

Z:\ CAP NUM OVR

2. STATA MAKES IT EASY TO WORK EFFICIENTLY

Do-file Editor - Manchester.do

File Edit Tools View

Manchester.do

```
*********************************************************************************
* 1. TWO-LEVEL MULTILEVEL MODELS
*********************************************************************************

* Open the tutorial data set
use "http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta", clear

* Fit a two-level (students within schools) variance components model to
* a continuous educational response variable, normexam. Note, you will need
* to click the "Resume Macro" button twice in MLwiN to return the model
* results to the Stata output window.
runmlwin normexam cons, ///
    level2(school: cons) ///
    level1(student: cons)

* Store the model estimates
estimates store model1

* Generate a boy dummy variable
generate boy = 1 - girl

* Extend the previous model to include fixed part covariates, a random school
* level slope and separate level 1 residuals for boys and girls. The runmlwin
* command also requests that runmlwin extracts the predicted values for the
* school level residuals from MLwiN and returns them to Stata. The nopause
* option prevents MLwiN from pausing before and after model estimation and so
* returns the model results automatically to Stata.
runmlwin normexam cons standlrt girl, ///
    level2(school: cons standlrt, residuals(u)) ///
    level1(student: girl boy, diagonal) nopause

* Store the model estimates
estimates store model2

* Perform a likelihood ratio test to compare the boy and girl residual
* variances
```

Ready Line: 10, Col: 34 CAP NUM OVR

3. BINARY RESPONSE MODELS

Random slope logistic model

$$\textbf{passexam}_{ij} \sim \text{Binomial}(1, \pi_{ij})$$

$$\text{logit}(\pi_{ij}) = \beta_0 + \beta_1 \textbf{standlrt}_{ij} + \beta_2 \textbf{girl}_{ij} + u_{0j} + u_{1j} \textbf{standlrt}_{ij}$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim \text{N} \left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & \\ \sigma_{u01} & \sigma_{u1}^2 \end{pmatrix} \right\}$$

```
. generate passexam = (normexam>0)

. runmlwin passexam cons standlrt girl, ///

      level2(school: cons standlrt) ///

      level1(student:) ///

      discrete(dist(binomial) link(logit) denom(cons)) ///

      nogroup nopause
```

Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
.
. generate passexam = (normexam>0)

. runmlwin passexam cons standlrt girl, ///
>         level2(school: cons standlrt) ///
>         level1(student:) ///
>         discrete(distribution(binomial) link(logit) denominator(cons)) ///
>         nogroup nopause

MLwiN 2.25 multilevel model                     Number of obs      =      4059
Binomial logit response model
Estimation algorithm: IGLS, MQL1
Run time (seconds)   =       1.61
Number of iterations =          6

------------------------------------------------------------------------------
    passexam |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        cons |  -.0479964    .101761    -0.47   0.637    -.2474444    .1514515
    standlrt |   1.232918   .0581067    21.22   0.000     1.119031    1.346805
        girl |    .186636   .0956229     1.95   0.051    -.0007814    .3740534
------------------------------------------------------------------------------


------------------------------------------------------------------------------
   Random-effects Parameters |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
Level 2: school              |
                   var(cons) |   .3701358   .0822183       .208991    .5312807
           cov(cons,standlrt)|   .0444551   .0394446     -.0328549     .121765
               var(standlrt) |     .06152   .0364277      -.009877    .1329169
------------------------------------------------------------------------------

.
.
```

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Fit model by PQL2 using MQL1 estimates as starting values

$$\mathbf{passexam}_{ij} \sim \text{Binomial}(1, \pi_{ij})$$

$$\text{logit}(\pi_{ij}) = \beta_0 + \beta_1 \mathbf{standlrt}_{ij} + \beta_2 \mathbf{girl}_{ij} + u_{0j} + u_{1j} \mathbf{standlrt}_{ij}$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim \text{N}\left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & \\ \sigma_{u01} & \sigma_{u1}^2 \end{pmatrix} \right\}$$

```
. runmlwin passexam cons standlrt girl, ///
      level2(school: cons standlrt) ///
      level1(student:) ///
      discrete(d(binomial) l(logit) de(cons) pql2) ///
      initsprevious nopause
```

Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
. runmlwin passexam cons standlrt girl, ///
>         level2(school: cons standlrt) ///
>         level1(student:) ///
>         discrete(dist(binomial) link(logit) denom(cons) pql2) ///
>         initsprevious nogroup nopause

Model fitted using initial values specified as parameter estimates from previous model

MLwiN 2.25 multilevel model                     Number of obs      =      4059
Binomial logit response model
Estimation algorithm: IGLS, PQL2
Run time (seconds)   =       2.04
Number of iterations =          8

------------------------------------------------------------------------------
    passexam |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        cons |  -.0367105   .1120693    -0.33   0.743    -.2563622    .1829413
    standlrt |   1.358886   .0642726    21.14   0.000     1.232914    1.484858
        girl |   .2012481   .1013948     1.98   0.047     .0025179    .3999782
------------------------------------------------------------------------------


------------------------------------------------------------------------------
   Random-effects Parameters |   Estimate   Std. Err.     [95% Conf. Interval]
-----------------------------+------------------------------------------------
Level 2: school              |
                   var(cons) |   .4740776   .1031501      .2719071     .676248
          cov(cons,standlrt) |   .0625434   .0491646     -.0338175    .1589043
               var(standlrt) |   .0764959   .0443148     -.0103596    .1633514
------------------------------------------------------------------------------

.
.
```

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Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
.
. estimates table mql1 pql2, ///
>         stats(ll N) b(%4.3f) stfmt(%4.0f) varwidth(18) newpanel
```

Variable	mql1	pql2
FP1		
cons	-0.048	-0.037
standlrt	1.233	1.359
girl	0.187	0.201
RP2		
var(cons)	0.370	0.474
cov(cons\standlrt)	0.044	0.063
var(standlrt)	0.062	0.076
RP1		
var(bcons_1)	1.000	1.000

Statistics	mql1	pql2
ll		
N	4059	4059

```
.
.
.
.
.
```

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4. SIMULATION STUDIES ARE NOW EASY

Do-file Editor - rodriguez and goldman (1995).do

File Edit Tools View

rodriguez and goldman (1995).do

```
* REPLICATE RODRIGUEZ AND GOLDMAN (1995)
clear
set seed 12345
postutil clear
postfile MQL1 ix fx cx sigmaf sigmac using "MQL1.dta", replace
set obs 2
generate cx = _n - 1
expand 10
sort cx
generate cid = _n
expand 2
bysort cid: gen fx = _n - 1
expand 10
bysort cid (fx): generate fid = _n
expand 2
bysort cid fid: gen ix = _n - 1
expand 10
bysort cid fid (ix): gen iid = _n
generate cons = 1
forvalues iteration = 1/100 {
    display _n(5) as txt "Iteration " as res "`iteration'" as txt " of " as res "100"
    generate c = rnormal(0,1)
    bysort cid (fid iid): replace c = c[1]
    generate f = rnormal(0,1)
    bysort cid fid (iid): replace f = f[1]
    generate y = rbinomial(1,invlogit(0*cons + 1*ix + 1*fx + 1*cx + f + c))
    runmlwin y cons ix fx cx, level3(cid: cons) level2(fid: cons) level1(iid:) ///
        discrete(distribution(binomial) link(logit) denominator(cons)) ///
        nopause
    post MQL1 ([FP1]ix) ([FP1]fx) ([FP1]cx) (sqrt([RP2]var(cons))) (sqrt([RP3]var(cons)))
    drop c f y
}
postclose MQL1
use "MQL1.dta", clear
tabstat ix fx cx sigmaf sigmac, format(%3.2f)
```

Ready Line: 21, Col: 41 CAP NUM OVR

5. MCMC ESTIMATION

Random slope logistic model

$$\mathbf{passexam}_{ij} \sim \text{Binomial}(1, \pi_{ij})$$

$$\text{logit}(\pi_{ij}) = \beta_0 + \beta_1 \mathbf{standlrt}_{ij} + \beta_2 \mathbf{girl}_{ij} + u_{0j} + u_{1j} \mathbf{standlrt}_{ij}$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim \text{N} \left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2_{u0} & \\ \sigma_{u01} & \sigma^2_{u1} \end{pmatrix} \right\}$$

```
. runmlwin passexam cons standlrt girl, ///
      level2(school: cons standlrt) ///
      level1(student:) ///
      discrete(d(binomial) l(logit) de(cons)) ///
      mcmc(burnin(500) chain(5000)) ///
      initsprevious nogroup nopause
```

Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
.
. runmlwin passexam cons standlrt girl, ///
>         level2(school: cons standlrt) level1(student:) ///
>         discrete(d(binomial) l(logit) de(cons)) ///
>         mcmc(burnin(500) chain(5000)) initsprevious nogroup nopause

MLwiN 2.25 multilevel model                    Number of obs      =      4059
Binomial logit response model
Estimation algorithm: MCMC
Burnin                     =        500
Chain                      =       5000
Thinning                   =          1
Run time (seconds)         =       30.1
Deviance (dbar)            =    4232.10
Deviance (thetabar)        =    4159.24
Effective no. of pars (pd) =      72.86
Bayesian DIC               =    4304.96
------------------------------------------------------------------------------
    passexam |      Mean    Std. Dev.     ESS     P       [95% Cred. Interval]
-------------+----------------------------------------------------------------
        cons |  -.0347943   .1073479      94   0.381    -.2506524    .1779318
    standlrt |   1.35652    .0624149     496   0.000     1.231931    1.480608
        girl |   .1873172   .1005095     196   0.026    -.0023705    .3851183
------------------------------------------------------------------------------


------------------------------------------------------------------------------
   Random-effects Parameters |   Mean    Std. Dev.    ESS     [95% Cred. Int]
-----------------------------+------------------------------------------------
Level 2: school              |
                   var(cons) |  .5135376  .1199011   1030   .3204156  .7835187
          cov(cons,standlrt) |  .0668458  .0581714    198  -.0387322  .1982548
               var(standlrt) |  .0862781  .0467082     99   .0243268  .2023509
------------------------------------------------------------------------------
```

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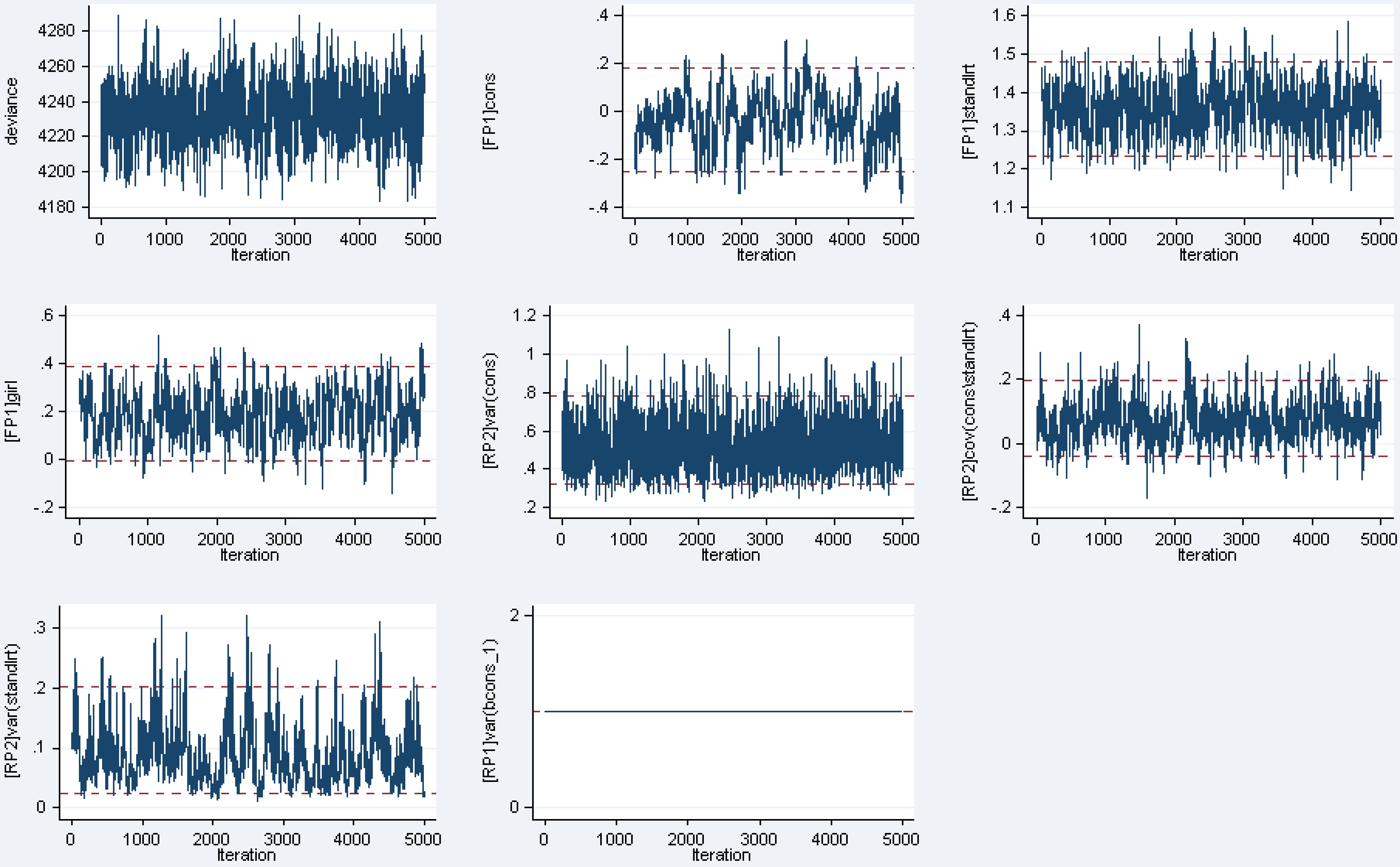
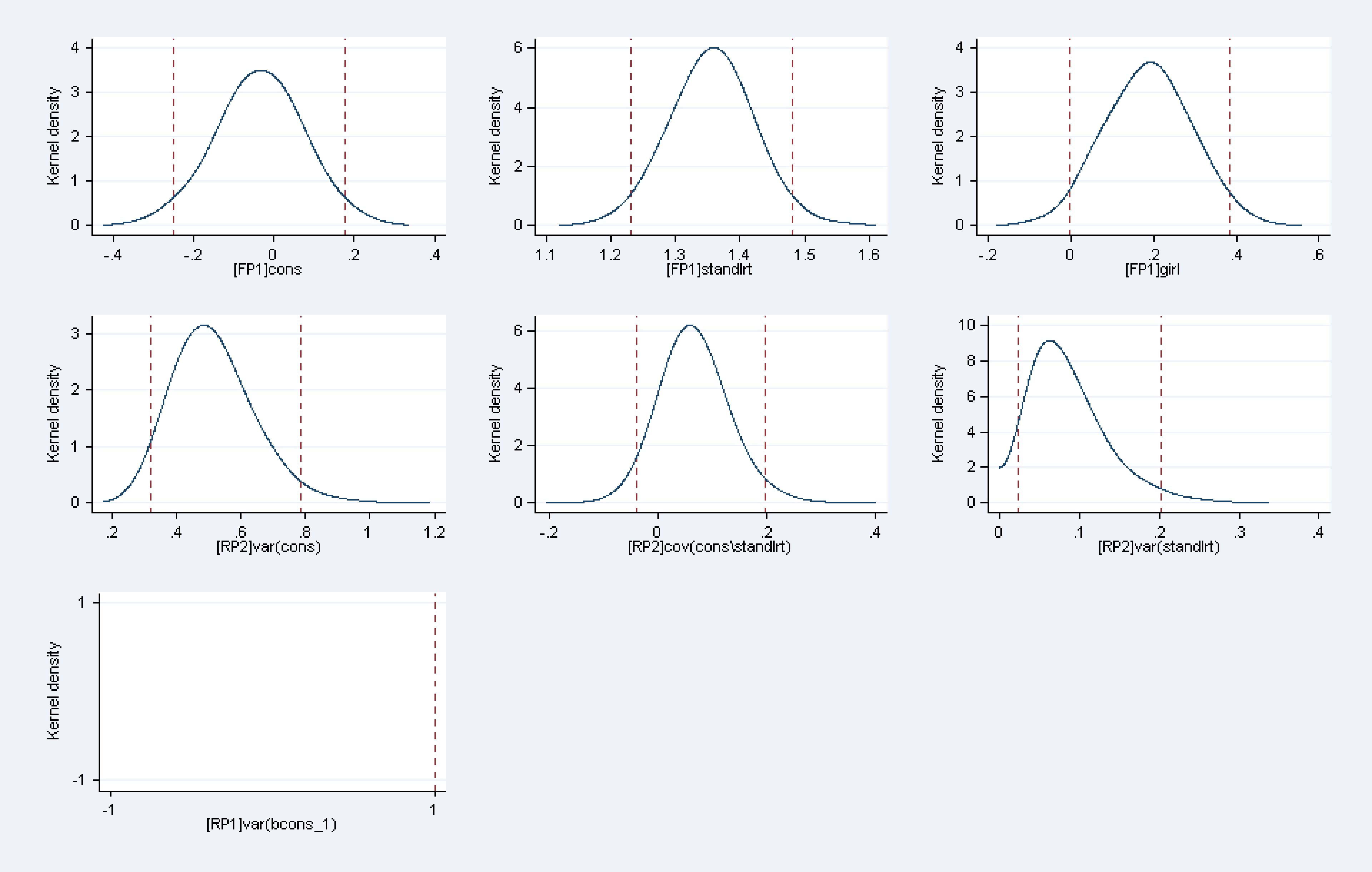
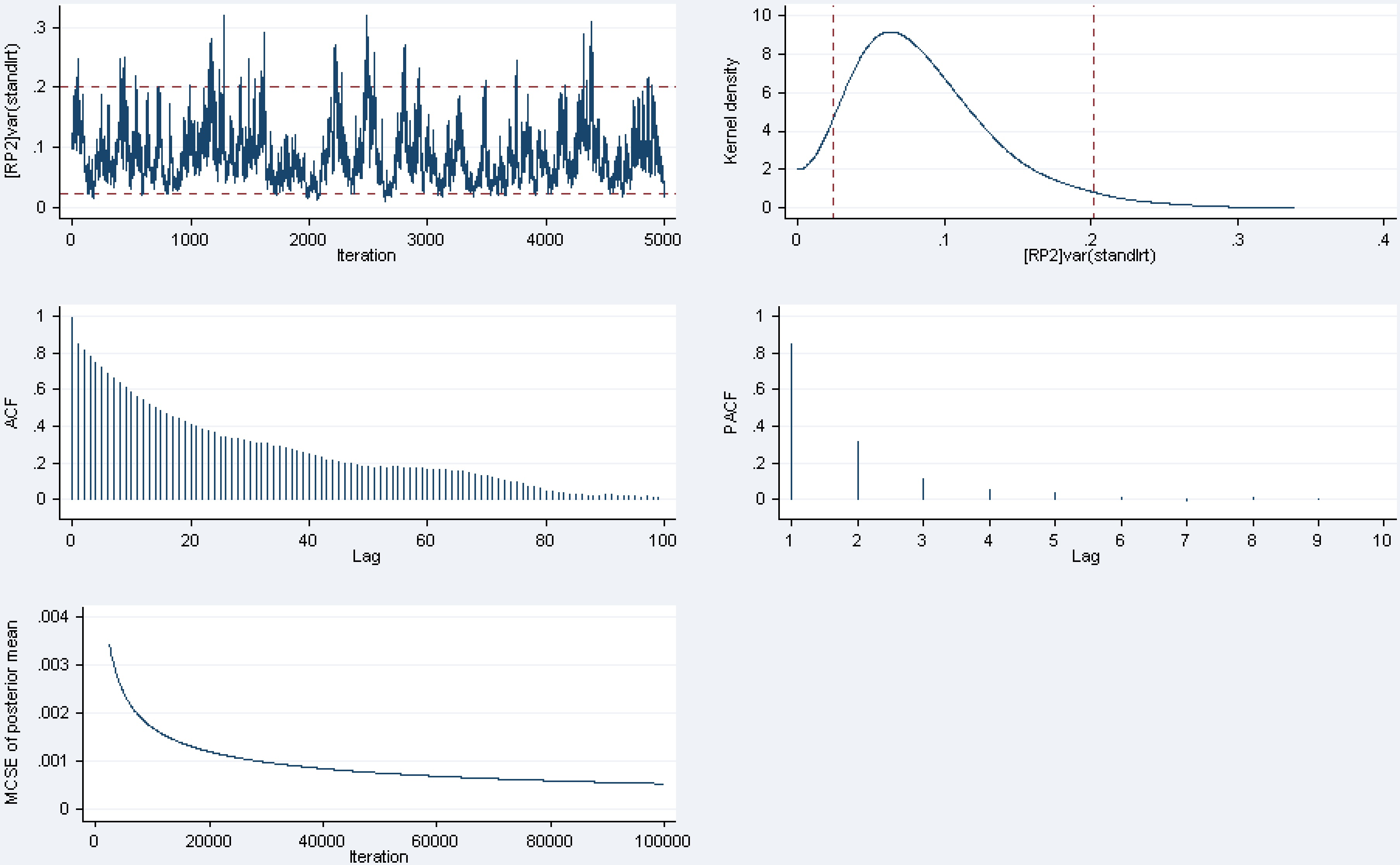



```
. mcmcsum, trajectories
```




```
. mcmcsum, densities
```




```
. mcmcsum [RP2]var(standlrt), fiveplot
```

Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
. mcmcsum [RP2]var(standlrt), detail

                              [RP2]var(standlrt)
-------------------------------------------------------------------------------
                                 Percentiles
Mean              .0862781       0.5%    .0193246     Thinned Chain Length       5000
MCSE of Mean      .0024099       2.5%    .0243268     Effective Sample Size        99
Std. Dev.         .0467082         5%    .0298808     Raftery Lewis (2.5%)      25770
Mode              .0631075        25%    .0520173     Raftery Lewis (97.5%)     23976
P(mean)                  0                            Brooks Draper (mean)     446390
P(mode)                  0        50%    .0765091
P(median)                0
                                  75%    .1100566
                                  95%     .179421
                                97.5%    .2023509
                                99.5%    .2549108
-------------------------------------------------------------------------------

.
.
.
.
.
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```

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Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
. runmlwin, nogroup mode or sd correlation

MLwiN 2.25 multilevel model                     Number of obs      =      4059
Binomial logit response model
Estimation algorithm: MCMC
Burnin                     =        500
Chain                      =       5000
Thinning                   =          1
Run time (seconds)         =       30.2
Deviance (dbar)            =    4232.10
Deviance (thetabar)        =    4159.24
Effective no. of pars (pd) =      72.86
Bayesian DIC               =    4304.96
------------------------------------------------------------------------------
    passexam |  Odds Ratio   Std. Dev.       ESS     P     [95% Cred. Interval]
-------------+----------------------------------------------------------------
        cons |    .9579759   .1042228         93   0.381     .7782928   1.194744
    standlrt |    3.884481   .2435176        497   0.000     3.427844   4.395619
        girl |    1.205355    .122038        195   0.026     .9976324   1.469788
------------------------------------------------------------------------------


------------------------------------------------------------------------------
   Random-effects Parameters |     Mode   Std. Dev.    ESS     [95% Cred. Int]
-----------------------------+------------------------------------------------
Level 2: school              |
                   sd(cons)  |  .7030943   .0822202   1013    .5660527  .8851659
        corr(cons,standlrt)  |  .3872765   .2455501    210   -.2034665  .7475395
               sd(standlrt)  |  .2642264   .0760582     91    .1559704  .4498343
------------------------------------------------------------------------------

.
.
```

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6. EXPORT MODELS TO WinBUGS

Random slope logistic model

$$\mathbf{passexam}_{ij} \sim \text{Binomial}(1, \pi_{ij})$$

$$\text{logit}(\pi_{ij}) = \beta_0 + \beta_1 \mathbf{standlrt}_{ij} + \beta_2 \mathbf{girl}_{ij} + u_{0j} + u_{1j} \mathbf{standlrt}_{ij}$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim \text{N}\left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2_{u0} & \\ \sigma_{u01} & \sigma^2_{u1} \end{pmatrix} \right\}$$

```
. runmlwin passexam cons standlrt girl, ///
      level2(school: cons standlrt) ///
      level1(student:) ///
      discrete(d(binomial) l(logit) de(cons)) ///
      mcmc(b(500) c(5000) savewinbugs(model(m.txt)
      inits(i.txt) data(d.txt) nofit)) ///
      initsprevious nogroup nopause
```

Viewer - view m.txt

File Edit History Help

view m.txt

Dialog | Also See | Jump To

```
# WINBUGS 1.4 code generated from MLwiN program

#----MODEL Definition----------------

model
{
# Level 1 definition
for(i in 1:N) {
passexam[i] ~ dbin(p[i],denom[i])
logit(p[i]) <- beta[1] * cons[i]
+ beta[2] * standlrt[i]
+ beta[3] * girl[i]
+ u2[school[i],1] * cons[i]
+ u2[school[i],2] * standlrt[i]
}
# Higher level definitions
for (j in 1:n2) {
u2[j,1:2] ~ dmnorm(zero2[1:2],tau.u2[1:2,1:2])
}
# Priors for fixed effects
for (k in 1:3) { beta[k] ~ dflat() }
# Priors for random terms
for (i in 1:2) {zero2[i] <- 0}
tau.u2[1:2,1:2] ~ dwish(R2[1:2, 1:2],2)
sigma2.u2[1:2,1:2] <- inverse(tau.u2[,])
}
```

Ready CAP NUM OVR

7. SPEED COMPARISONS

`runmlwin` vs. `xtmixed`

- Simulated data: 130,000 students in 650 schools (200 students per school)

$$\mathbf{normexam}_{ij} = \beta_0 + \beta_1\mathbf{standlrt}_{ij} + \beta_2\mathbf{girl}_{ij} + u_{0j} + u_{1j}\mathbf{standlrt}_{ij}$$

$$+e_{2ij}\mathbf{girl}_{ij} + e_{3ij}\mathbf{boy}_{ij}$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim \mathrm{N}\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2_{u0} & \\ \sigma_{u01} & \sigma^2_{u1} \end{pmatrix}\right\}$$

$$\begin{pmatrix} e_{2ij} \\ e_{3ij} \end{pmatrix} \sim \mathrm{N}\left\{\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma^2_{e2} & \\ 0 & \sigma^2_{e3} \end{pmatrix}\right\}$$

Software method	Seconds	β_0	β_1	β_2	σ^2_{u0}	σ_{u01}	σ^2_{u1}	σ^2_{e2}	σ^2_{e3}
True values	–	0.00	0.50	0.20	0.10	0.00	0.05	0.50	0.60
`runmlwin`	6	-0.01	0.50	0.20	0.10	0.01	0.05	0.50	0.60
`xtmixed`	158	-0.01	0.50	0.20	0.10	0.01	0.05	0.50	0.60

`runmlwin` vs. `xtmelogit`

$$\mathbf{passexam}_{ij} \sim \text{Binomial}(1, \pi_{ij})$$

$$\text{logit}(\pi_{ij}) = \beta_0 + \beta_1 \mathbf{standlrt}_{ij} + \beta_2 \mathbf{girl}_{ij} + u_{0j} + u_{1j}\mathbf{standlrt}_{ij}$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim \text{N}\left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & \\ \sigma_{u01} & \sigma_{u1}^2 \end{pmatrix} \right\}$$

Software method	Seconds	β_0	β_1	β_2	σ_{u0}^2	σ_{u01}	σ_{u1}^2
True values	–	0.00	1.50	0.20	0.50	0.00	0.10
`runmlwin, mql1`	9	-0.01	1.32	0.18	0.40	0.00	0.13
`runmlwin, pql2`	14	-0.01	1.49	0.20	0.50	-0.00	0.12
`runmlwin, b(200) c(1000)`	313	0.00	1.49	0.21	0.50	-0.00	0.11
`runmlwin, b(500) c(5000)`	310	0.00	1.49	0.21	0.50	-0.00	0.11
`xtmelogit, intpoints(1)`	265	-0.01	1.49	0.20	0.50	-0.00	0.11
`xtmelogit, intpoints(7)`	451	-0.01	1.49	0.20	0.50	-0.00	0.12

8. MORE COMPLEX ANALYSES

Five interesting extensions

1. Use `runmlwin` to quickly obtain approximate quasilikelihood estimates for discrete response models; then finish off estimation using adaptive quadrature in `gllamm`

2. Use `runmlwin` to fit 'disease mapping' spatial multilevel models and then plot thematic maps of the area-level residuals using the `spmap` command

3. After fitting model by MCMC using `runmlwin`, use `mcmcsum` to pull back MCMC chains in order to derive posterior distribution for any function of the parameters and data of interest (e.g. ICC or ranks of random effects)

4. Use the `realcomimpute` command to generate multiply imputed data sets; then use the `runmlwin` command with the `mi estimate` prefix to fit the model of interest to each data set and to combine results using 'Rubin's rules'

5. Use `runmlwin` to generate WinBUGS model, data and initial values files for any MLwiN MCMC model; then fit the model in WinBUGS using the `winbugs` command; then interpret chains using the mcmcsum command

9. RESOURCES TO HELP YOU LEARN `runmlwin`

Viewer - help runmlwin

File Edit History Help

help runmlwin

help runmlwin ✕

Dialog Also See Jump To

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*]

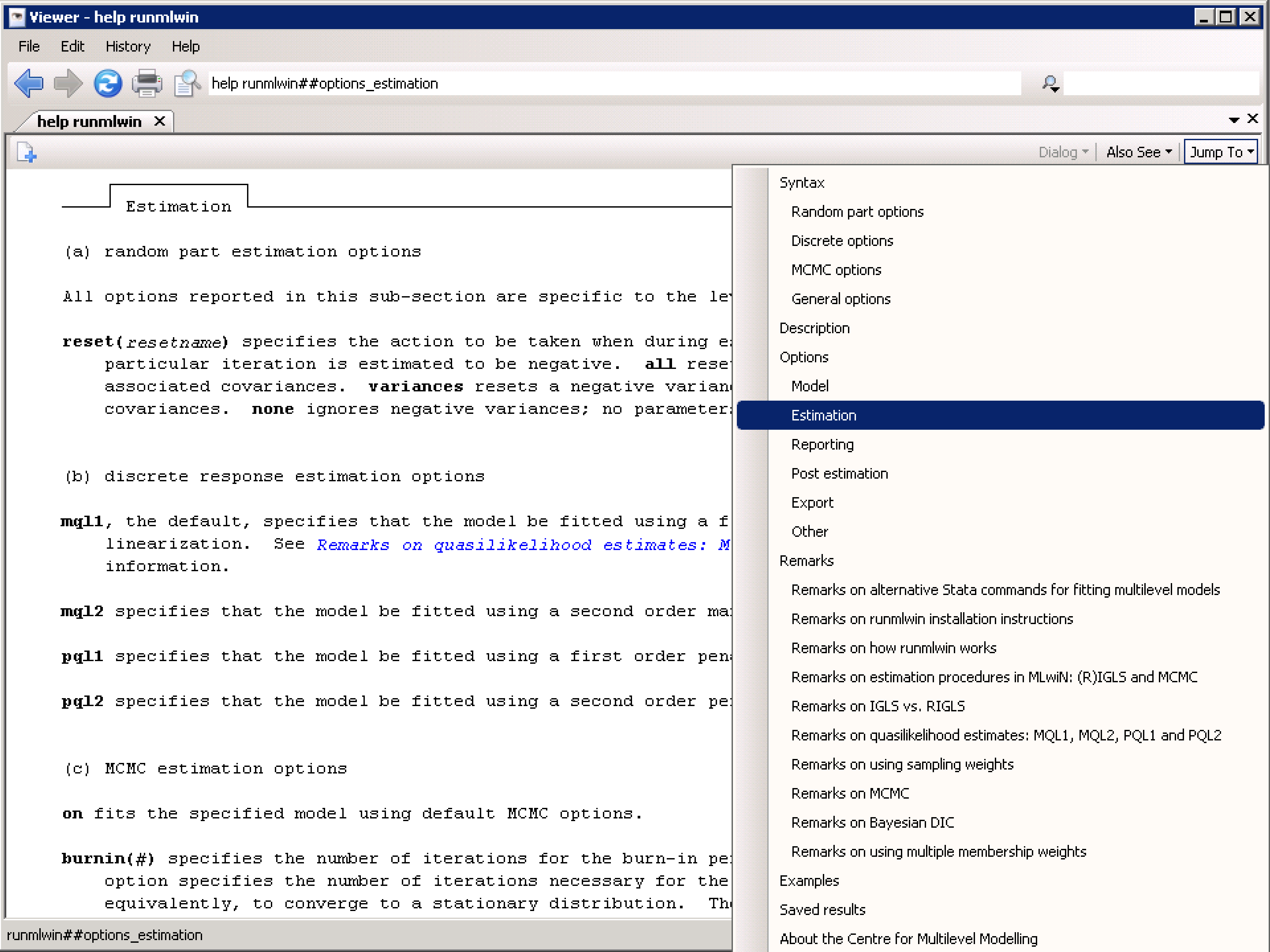
for univariate ordered and unordered categorical response models

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 included in the model. The total number of contrasts will be one less than the number of response categories.

for multivariate response models

Ready CAP NUM OVR


Viewer - help runmlwin
File Edit History Help
help runmlwin##options_estimation
help runmlwin
Dialog Also See Jump To
Estimation
(a) random part estimation options
All options reported in this sub-section are specific to the le
reset(resetname) specifies the action to be taken when during e
particular iteration is estimated to be negative. all rese
associated covariances. variances resets a negative varian
covariances. none ignores negative variances; no parameter
(b) discrete response estimation options
mql1, the default, specifies that the model be fitted using a f
linearization. See Remarks on quasilikelihood estimates: M
information.
mql2 specifies that the model be fitted using a second order ma
pql1 specifies that the model be fitted using a first order pen
pql2 specifies that the model be fitted using a second order pe
(c) MCMC estimation options
on fits the specified model using default MCMC options.
burnin(#) specifies the number of iterations for the burn-in pe
option specifies the number of iterations necessary for the
equivalently, to converge to a stationary distribution. Th
runmlwin##options_estimation
Syntax
Random part options
Discrete options
MCMC options
General options
Description
Options
Model
Estimation
Reporting
Post estimation
Export
Other
Remarks
Remarks on alternative Stata commands for fitting multilevel models
Remarks on runmlwin installation instructions
Remarks on how runmlwin works
Remarks on estimation procedures in MLwiN: (R)IGLS and MCMC
Remarks on IGLS vs. RIGLS
Remarks on quasilikelihood estimates: MQL1, MQL2, PQL1 and PQL2
Remarks on using sampling weights
Remarks on MCMC
Remarks on Bayesian DIC
Remarks on using multiple membership weights
Examples
Saved results
About the Centre for Multilevel Modelling

Viewer - help runmlwin

File Edit History Help

help runmlwin##examples

help runmlwin

Dialog Also See Jump To

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 runmlwin installation instructions* 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 page 28 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 page 59 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 page 59 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 1 variance function (fitted using IGLS)

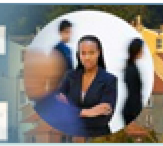
(See page 99 of the MLwiN User Manual)

```
. matrix A = (1,1,0,0,0,1)
. runmlwin normexam cons standlrt girl, level2(school: cons standlrt) level1(student: cons standlrt
    girl, elements(A)) nopause
```

Ready CAP NUM OVR

University of BRISTOL

Centre for Multilevel Modelling



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- MLwiN
- Realcom
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runmlwin: Running MLwiN from within Stata

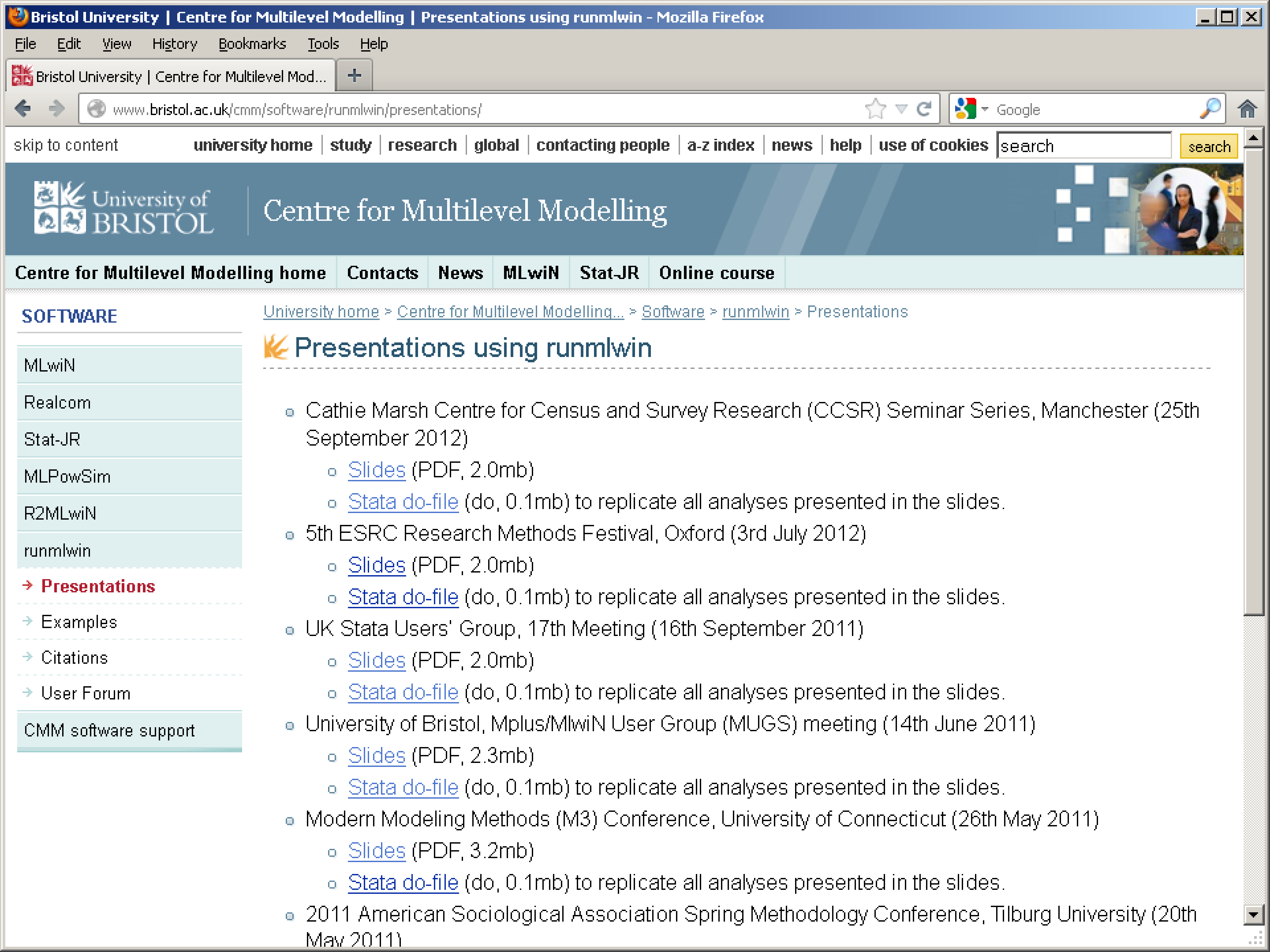
runmlwin is a Stata command which allows Stata users to run the powerful MLwiN multilevel modelling software from within Stata.

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)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Presentations using runmlwin
Cathie Marsh Centre for Census and Survey Research (CCSR) Seminar Series, Manchester (25th September 2012)
Slides (PDF, 2.0mb)
Stata do-file (do, 0.1mb) to replicate all analyses presented in the slides.
5th ESRC Research Methods Festival, Oxford (3rd July 2012)
Slides (PDF, 2.0mb)
Stata do-file (do, 0.1mb) to replicate all analyses presented in the slides.
UK Stata Users' Group, 17th Meeting (16th September 2011)
Slides (PDF, 2.0mb)
Stata do-file (do, 0.1mb) to replicate all analyses presented in the slides.
University of Bristol, Mplus/MlwiN User Group (MUGS) meeting (14th June 2011)
Slides (PDF, 2.3mb)
Stata do-file (do, 0.1mb) to replicate all analyses presented in the slides.
Modern Modeling Methods (M3) Conference, University of Connecticut (26th May 2011)
Slides (PDF, 3.2mb)
Stata do-file (do, 0.1mb) to replicate all analyses presented in the slides.
2011 American Sociological Association Spring Methodology Conference, Tilburg University (20th May 2011)

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. (2009) 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 attempted to replicate the analysis in 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)

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www.cmm.bristol.ac.uk/forum/viewforum.php?f=3&sid=c02eb83ee7551a02aab87d736c4b36ed

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Forum rules

NEWTOPIC Search this forum... Search

96 topics • Page 1 of 4 • 1 2 3 4

ANNOUNCEMENTS	REPLIES	VIEWS	LAST POST
runmlwin has had 2300+ downloads since Oct 2011 by GeorgeLeckie » Tue May 15, 2012 7:00 pm	0	1009	by GeorgeLeckie Tue May 15, 2012 7:00 pm
Make sure you have latest version of runmlwin: 16/04/2012 by GeorgeLeckie » Tue May 01, 2012 3:21 pm	0	1111	by GeorgeLeckie Tue May 01, 2012 3:21 pm
Do-files to replicate entire MLwiN User & MCMC Manuals by GeorgeLeckie » Mon Apr 18, 2011 4:30 pm	7	2131	by GeorgeLeckie Tue Mar 13, 2012 2:47 pm
Welcome to the runmlwin discussion forum by GeorgeLeckie » Fri Apr 01, 2011 3:06 pm	0	1195	by GeorgeLeckie Fri Apr 01, 2011 3:06 pm

TOPICS	REPLIES	VIEWS	LAST POST
trouble fitting cross-classified model by katetilling » Tue Sep 18, 2012 7:43 am	3	25	by katetilling Tue Sep 18, 2012 6:49 pm
error in multiple membership models by morning03 » Thu Sep 13, 2012 5:45 am	4	34	by morning03 Sun Sep 16, 2012 4:34 am
Spatial multilevel models by Raphael » Wed Sep 12, 2012 10:00 pm	2	13	by Raphael Fri Sep 14, 2012 3:25 am
signs of covariates change using multiple membership model by morning03 » Fri Sep 07, 2012 4:02 am	1	26	by GeorgeLeckie Mon Sep 10, 2012 4:57 pm
can't proceed to multiple membership model by morning03 » Wed Aug 22, 2012 4:25 am	3	61	by GeorgeLeckie Thu Aug 23, 2012 10:17 am
Gamma Regression with random effects by AndreasHaupt » Mon Aug 13, 2012 11:03 am	2	41	by AndreasHaupt Mon Aug 13, 2012 11:37 am
Significance of random effects in cross-classified model by AnjaScheiwe » Sun Aug 12, 2012 1:36 am	2	42	by AnjaScheiwe Mon Aug 13, 2012 10:02 am

Leckie and Charlton (2012) runmlwin - Run MLwiN from within Stata.pdf - Adobe Reader

File Edit View Document Tools Window Help

Journal of Statistical Software

MMMMMM YYYY, Volume VV, Issue II. *http://www.jstatsoft.org/*

`runmlwin`: A Program to Run the MLwiN Multilevel Modelling Software from within Stata

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Abstract

We illustrate how to fit multilevel models in the MLwiN package seamlessly from within Stata using the Stata program `runmlwin`. We argue that using MLwiN and Stata in combination allows researchers to capitalise on the best features of both packages. We provide examples of how to use `runmlwin` to fit continuous, binary, ordinal, nominal and mixed response multilevel models by both maximum likelihood and Markov chain Monte Carlo estimation.

Keywords: `runmlwin`, MLwiN, Stata, multilevel model, random effects model, mixed model, hierarchical linear model, clustered data, maximum likelihood estimation, Markov chain Monte Carlo estimation.

10. RUN MLwiN FROM WITHIN R: THE `R2MLwiN` FUNCTION

Continuous and binary response random slope models

- Continuous response model

$$\mathbf{normexam}_{ij} = \beta_0 + \beta_1 \mathbf{standlrt}_{ij} + \beta_2 \mathbf{girl}_{ij} + u_{0j} + u_{1j} \mathbf{standlrt}_{ij}$$

$$+ e_{2ij} \mathbf{girl}_{ij} + e_{3ij} \mathbf{boy}_{ij}$$

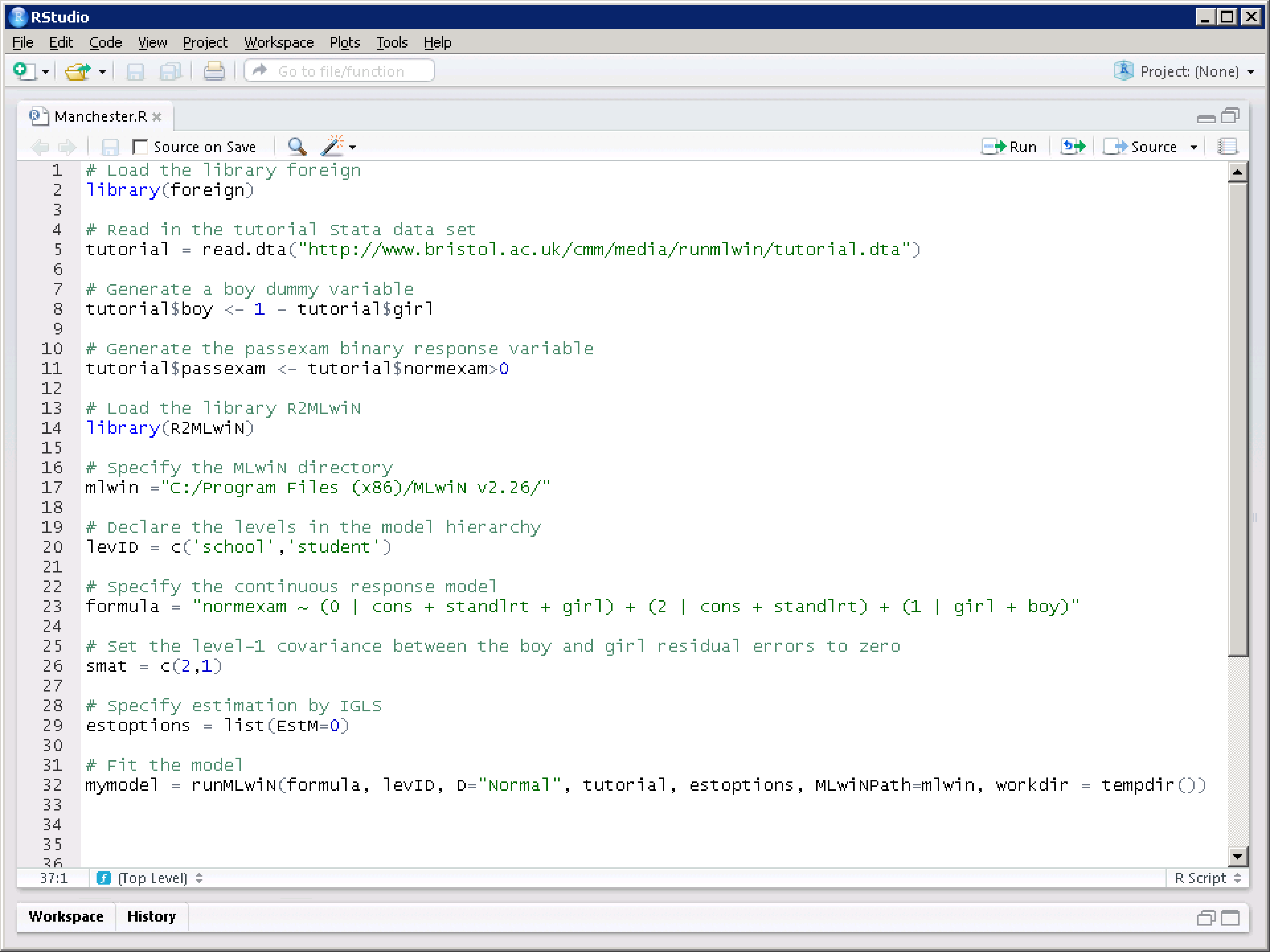
$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim \mathrm{N}\left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & \\ \sigma_{u01} & \sigma_{u1}^2 \end{pmatrix} \right\}, \qquad \begin{pmatrix} e_{2ij} \\ e_{3ij} \end{pmatrix} \sim \mathrm{N}\left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{e2}^2 & \\ 0 & \sigma_{e3}^2 \end{pmatrix} \right\}$$

- Binary response model

$$\mathbf{passexam}_{ij} \sim \mathrm{Binomial}(1, \pi_{ij})$$

$$\mathrm{logit}(\pi_{ij}) = \beta_0 + \beta_1 \mathbf{standlrt}_{ij} + \beta_2 \mathbf{girl}_{ij} + u_{0j} + u_{1j} \mathbf{standlrt}_{ij}$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \end{pmatrix} \sim \mathrm{N}\left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & \\ \sigma_{u01} & \sigma_{u1}^2 \end{pmatrix} \right\}$$


RStudio
File Edit Code View Project Workspace Plots Tools Help
Go to file/function
Project: (None)
Manchester.R
Source on Save
Run
Source
# Load the library foreign
library(foreign)
# Read in the tutorial Stata data set
tutorial = read.dta("http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta")
# Generate a boy dummy variable
tutorial$boy <- 1 - tutorial$girl
Generate the passexam binary response variable
tutorial$passexam <- tutorial$normexam>0
# Load the library R2MLwiN
library(R2MLwiN)
# Specify the MLwiN directory
mlwin ="C:/Program Files (x86)/MLwiN v2.26/"
# Declare the levels in the model hierarchy
levID = c('school','student')
# Specify the continuous response model
formula = "normexam ~ (0 | cons + standlrt + girl) + (2 | cons + standlrt) + (1 | girl + boy)"
# Set the level-1 covariance between the boy and girl residual errors to zero
smat = c(2,1)
# Specify estimation by IGLS
estoptions = list(EstM=0)
# Fit the model
mymodel = runMLwiN(formula, levID, D="Normal", tutorial, estoptions, MLwiNPath=mlwin, workdir = tempdir())
37:1
(Top Level)
R Script
Workspace
History

RStudio

File Edit Code View Project Workspace Plots Tools Help

Go to file/function Project: (None)

Console ~/

```
> # Fit the model
> mymodel = runMLwiN(formula, levID, D="Normal", tutorial, estoptions,
+                   MLwiNPath=mlwin, workdir = tempdir())


Worksheet has 50000000 spaces
ECHO     0

Execution completed
-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-
MLwiN multilevel model (Normal)
Estimation algorithm:  IGLS        Elapsed time : 0.54s
Number of obs:  4059
Deviance statistic:  9281.4
----------------------------------------------------------------------------------------------------
The model formula:
normexam~(0|cons+standlrt+girl)+(2|cons+standlrt)+(1|girl+boy)
Level 2: school     Level 1: student
----------------------------------------------------------------------------------------------------
The fixed part estimates:
              Coef.    Std. Err.        z      Pr(>|z|)          [95% Conf.   Interval]
cons       -0.11153     0.04331   -2.58      0.01001    *       -0.19641    -0.02665
standlrt    0.55294     0.02008   27.54    5.462e-167   ***      0.51359     0.59228
girl        0.17528     0.03242    5.41     6.401e-08   ***      0.11175     0.23881
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
----------------------------------------------------------------------------------------------------
The random part estimates at the school level:
                      Coef.    Std. Err.    [95% Conf.   Interval]
var_cons            0.08625     0.01717      0.05259      0.11991
cov_cons_standlrt   0.01905     0.00668      0.00596      0.03214
var_standlrt        0.01489     0.00447      0.00613      0.02365
----------------------------------------------------------------------------------------------------
The random part estimates at the student level:
                 Coef.    Std. Err.    [95% Conf.   Interval]
var_girl       0.52516     0.01528      0.49521      0.55512
cov_girl_boy   0.00000     0.00000      0.00000      0.00000
var_boy        0.58743     0.02100      0.54628      0.62859
-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-
```

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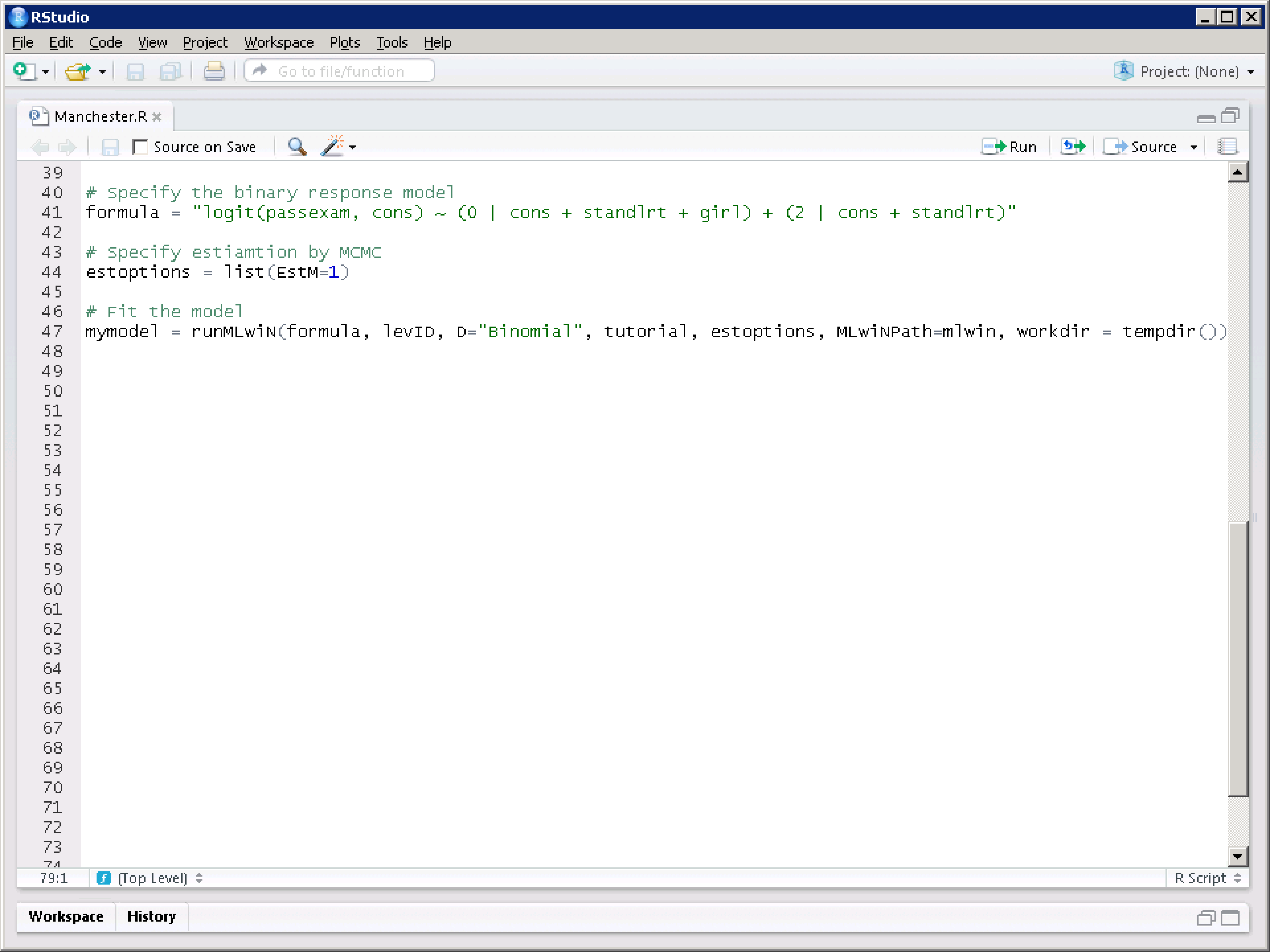
RStudio
File Edit Code View Project Workspace Plots Tools Help
Go to file/function
Project: (None)
Manchester.R
Source on Save
Run
Source
# Specify the binary response model
formula = "logit(passexam, cons) ~ (0 | cons + standlrt + girl) + (2 | cons + standlrt)"
# Specify estiamtion by MCMC
estoptions = list(EstM=1)
# Fit the model
mymodel = runMLwiN(formula, levID, D="Binomial", tutorial, estoptions, MLwiNPath=mlwin, workdir = tempdir())
79:1
(Top Level)
R Script
Workspace
History

RStudio

File Edit Code View Project Workspace Plots Tools Help

Go to file/function   Project: (None)

Console ~/

```
Adapting for 1200 iterations (Maximum 5000)
Adapting for 1300 iterations (Maximum 5000)
Adapting for 1400 iterations (Maximum 5000)
Adapting for 1500 iterations (Maximum 5000)
Adapting for 1600 iterations (Maximum 5000)
Adapting finished and took 1700 iterations
Burning in for 0 iterations out of 500
Burning in for 100 iterations out of 500
Burning in for 200 iterations out of 500
Burning in for 300 iterations out of 500
Burning in for 400 iterations out of 500

Execution completed
-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-
MLwiN multilevel model (Binomial)
Estimation algorithm:  MCMC      Elapsed time : 28.4s
Number of obs:  4059             Number of iter.: 5000          Burn-in: 500
Bayesian Deviance Information Criterion (DIC)
Dbar        D(thetabar)    pD       DIC
4234.584   4162.498   72.087     4306.671
----------------------------------------------------------------------------------------------------
The model formula:
logit(passexam,cons)~(0|cons+standlrt+girl)+(2|cons+standlrt)
Level 2: school     Level 1: student
----------------------------------------------------------------------------------------------------
The fixed part estimates:
              Coef.    Std. Err.        z      Pr(>|z|)          [95% Conf.   Interval]   ESS
cons        -0.03707      0.10921   -0.34        0.7343          -0.24130     0.19745    82
standlrt     1.35860      0.06101   22.27   7.554e-110    ***      1.23754     1.47761   487
girl         0.19848      0.10172    1.95      0.05105    .      -0.00255     0.40455   137
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
----------------------------------------------------------------------------------------------------
The random part estimates at the school level:
                      Coef.    Std. Err.    [95% Conf.   Interval]    ESS
var_cons            0.51187      0.12163      0.31867     0.78817    939
cov_cons_standlrt   0.06201      0.05505     -0.04266     0.17783    159
var_standlrt        0.07720      0.04525      0.01987     0.18716     69
----------------------------------------------------------------------------------------------------
```

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R2MLwiN: Running MLwiN from within R

R2MLwiN is an R command interface to the MLwiN multilevel modelling software package, allowing users to fit multilevel models using MLwiN from within the R environment. It is designed to be used with versions of MLwiN from v2.25 onwards although some features will work with earlier versions.

Installation

Both MLwiN and R are required to use **R2MLwiN**. MLwiN is free to UK academics. A fully functional 30-day free version of MLwiN is available to all other users.

To install **R2MLwiN**, type the following at the R command line:

install.packages("R2MLwiN", repos="http://cran.r-project.org")

Documentation

To see the documentation for **R2MLwiN**, type the following at the R command line:

library(R2MLwiN)

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Examples using R2MLwiN

MLwiN User Manual

We provide R demos which allow you to replicate all the analysis reported in the MLwiN MCMC Manual (PDF, 7.4 mb) using R2MLwiN with the package. The table of contents are: