Running MLwiN from within Stata: the `runmlwin` command

Research Methods Festival
Oxford
3rd July 2012

George Leckie and Chris Charlton
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…
  - Zheng Zheng Zhang is developing `r2mlwin` to run MLwiN from within R
  - `r2mlwin` will provide 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 slow
- Other user-written multilevel modelling commands 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

1. CONTINUOUS RESPONSE MODELS

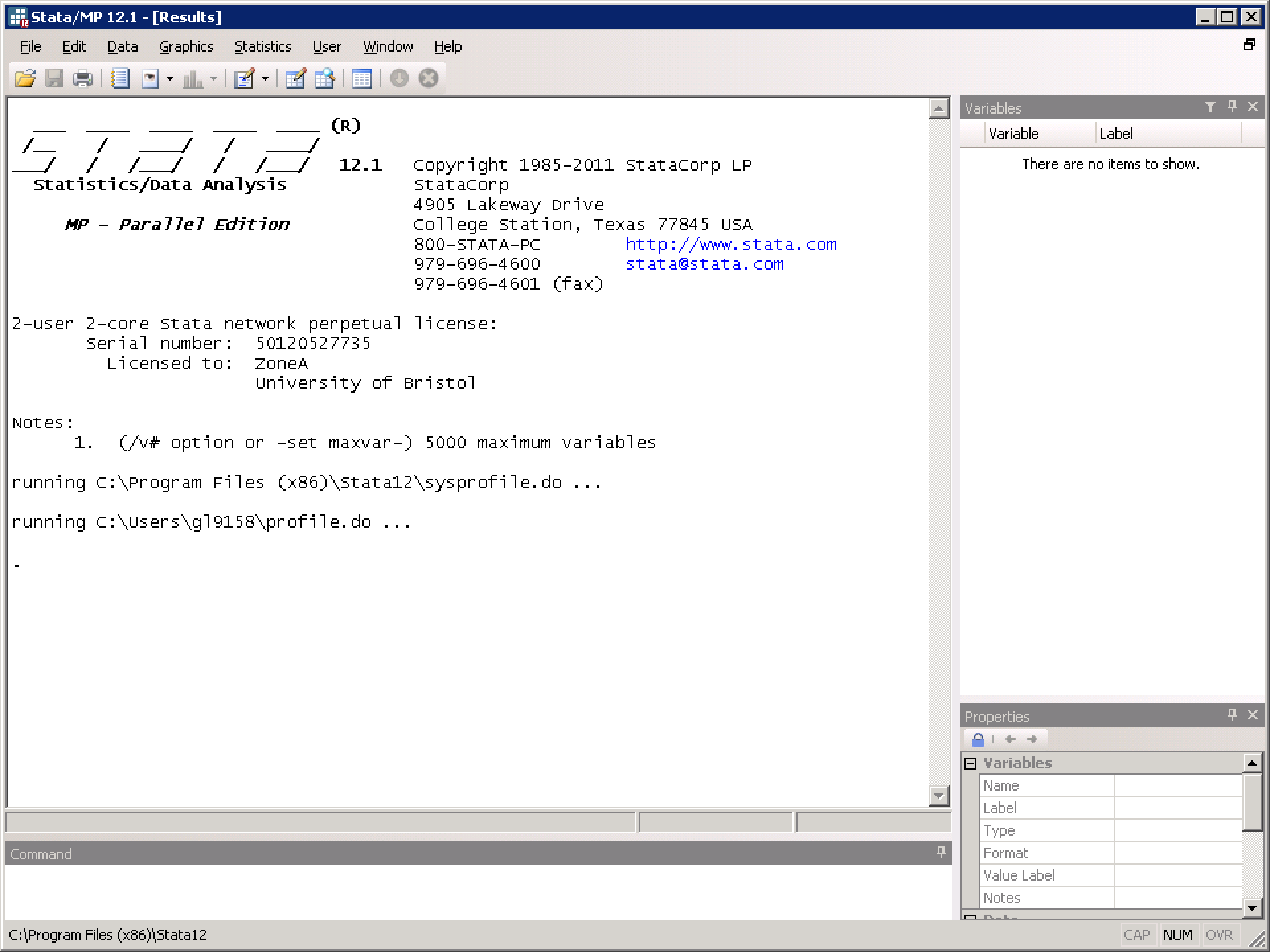
Two-level variance components model

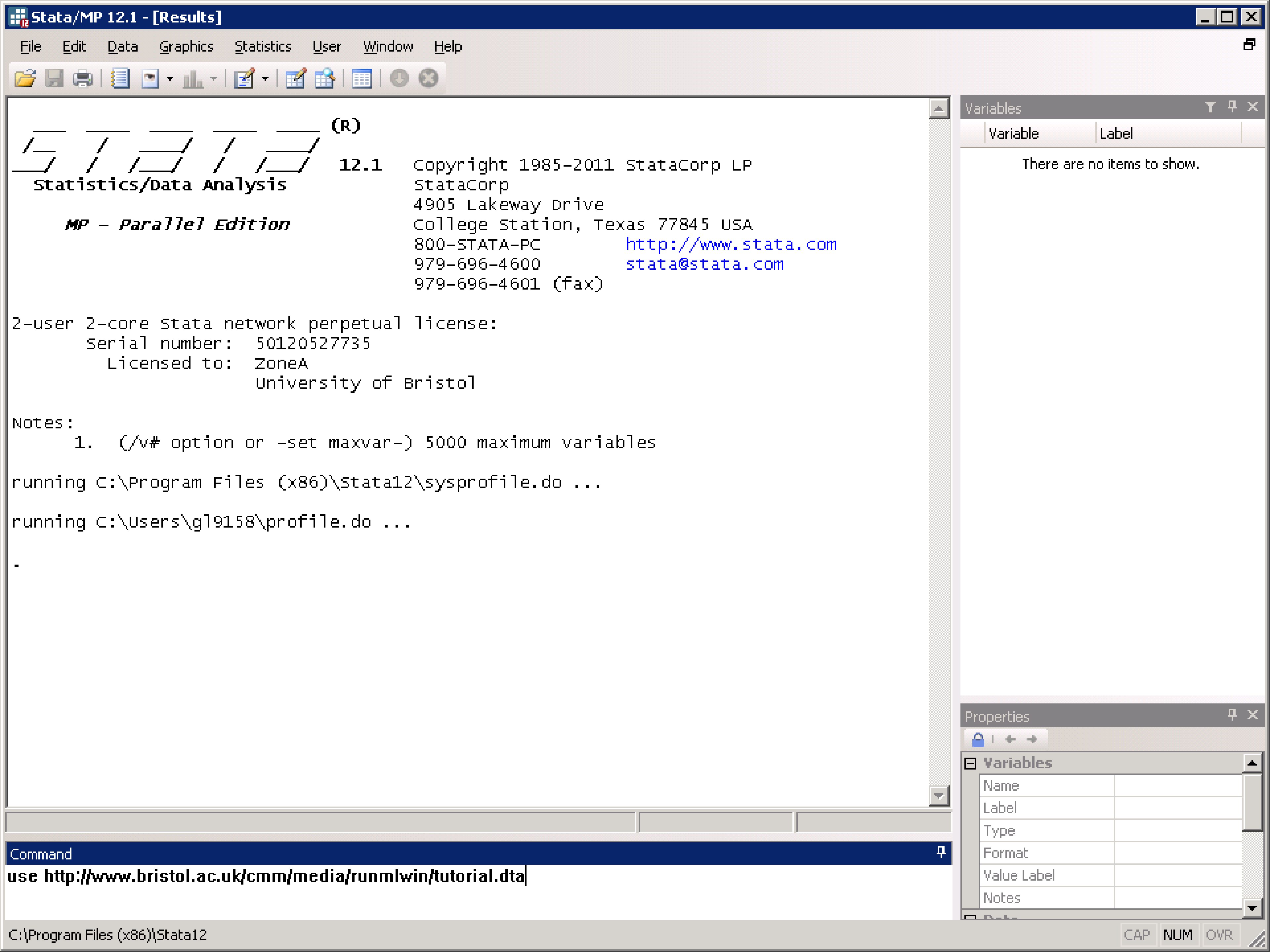
- Inner-London schools exam scores data set
- Main MLwiN User Manual example (the “tutorial” data set)
- 4059 students nested within 65 schools

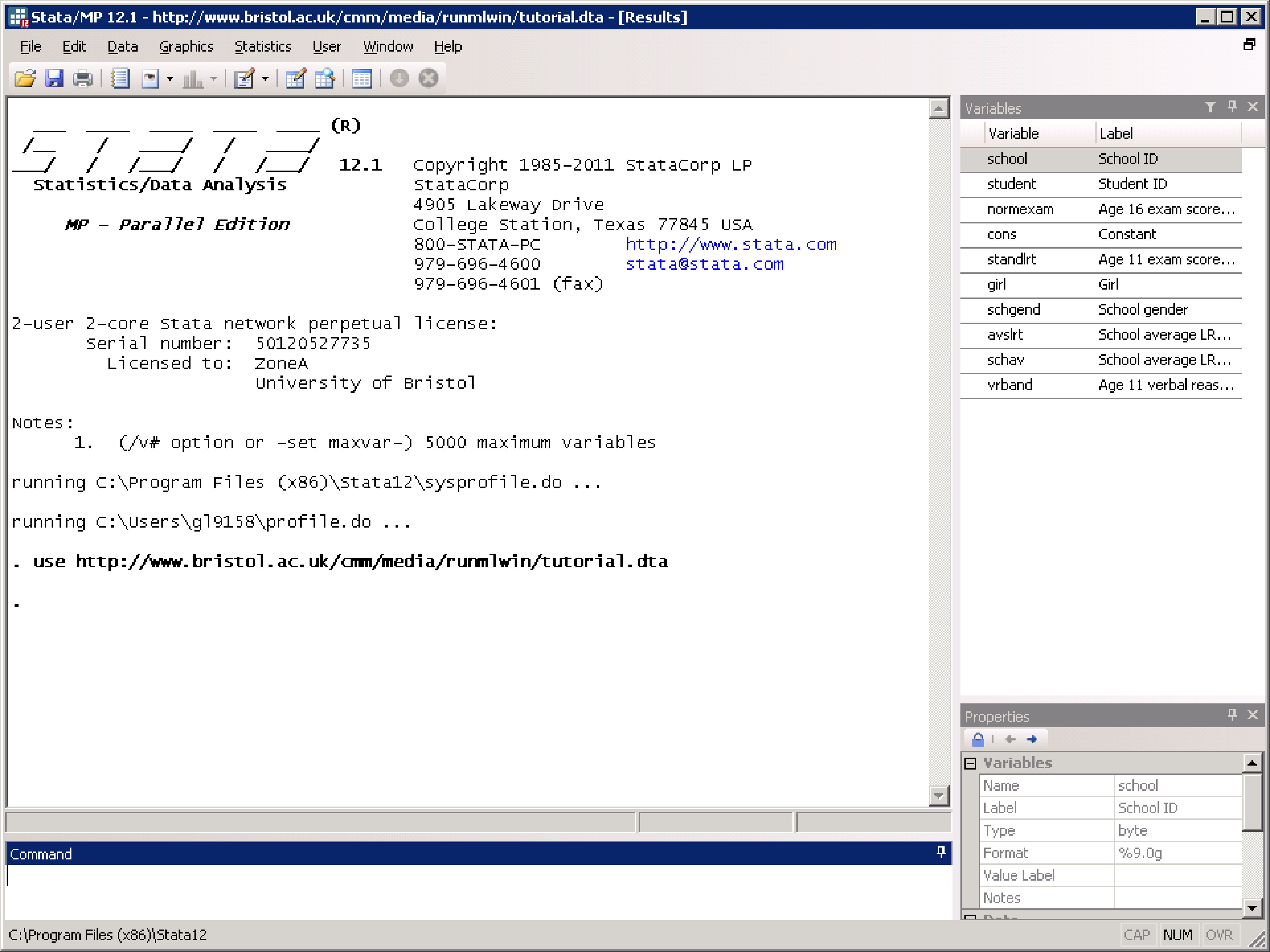
$$\mathbf{normexam}_{ij} = \beta_0 + u_j + e_{ij}$$

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

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


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


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

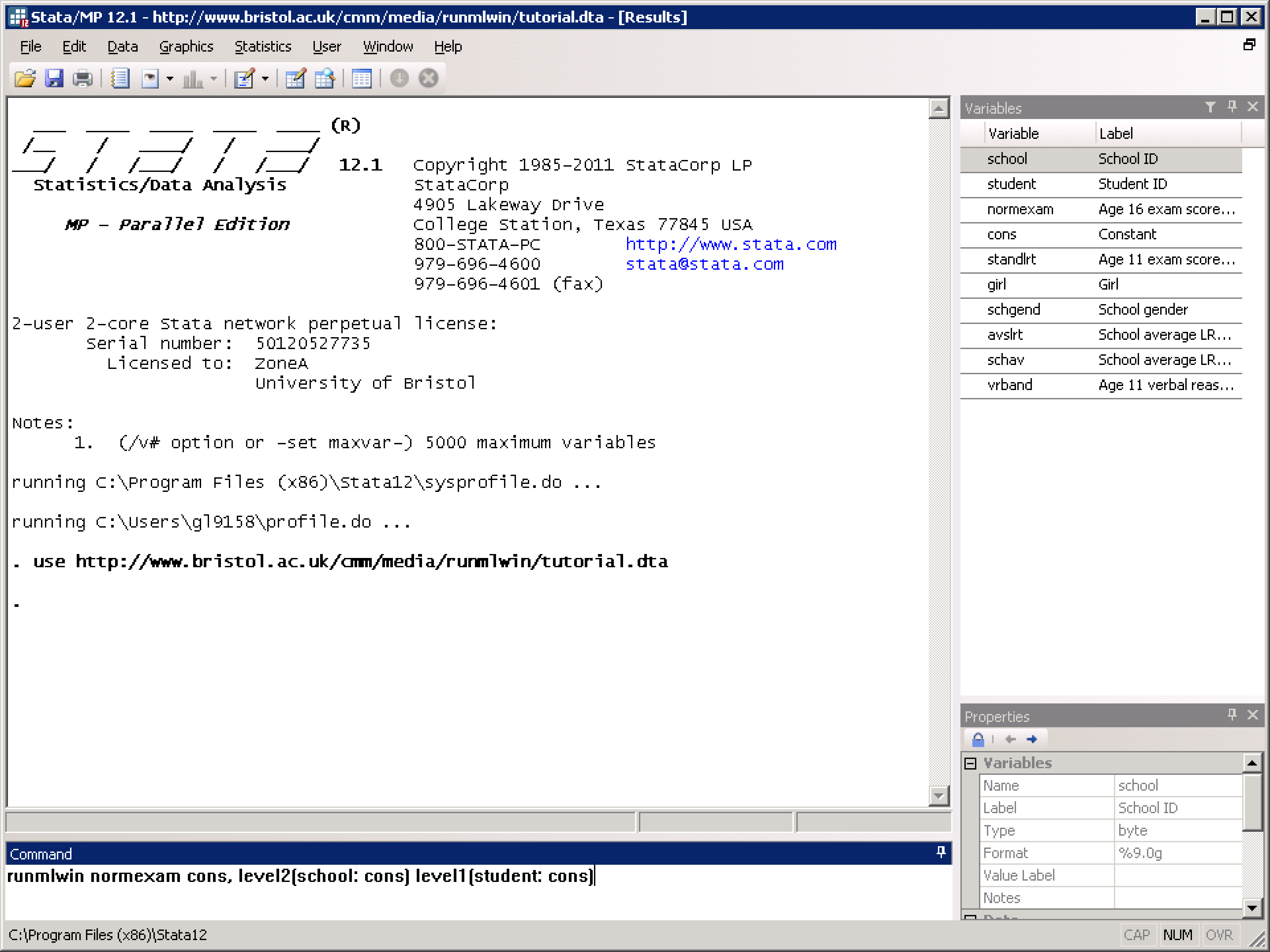
The `runmlwin` command syntax

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

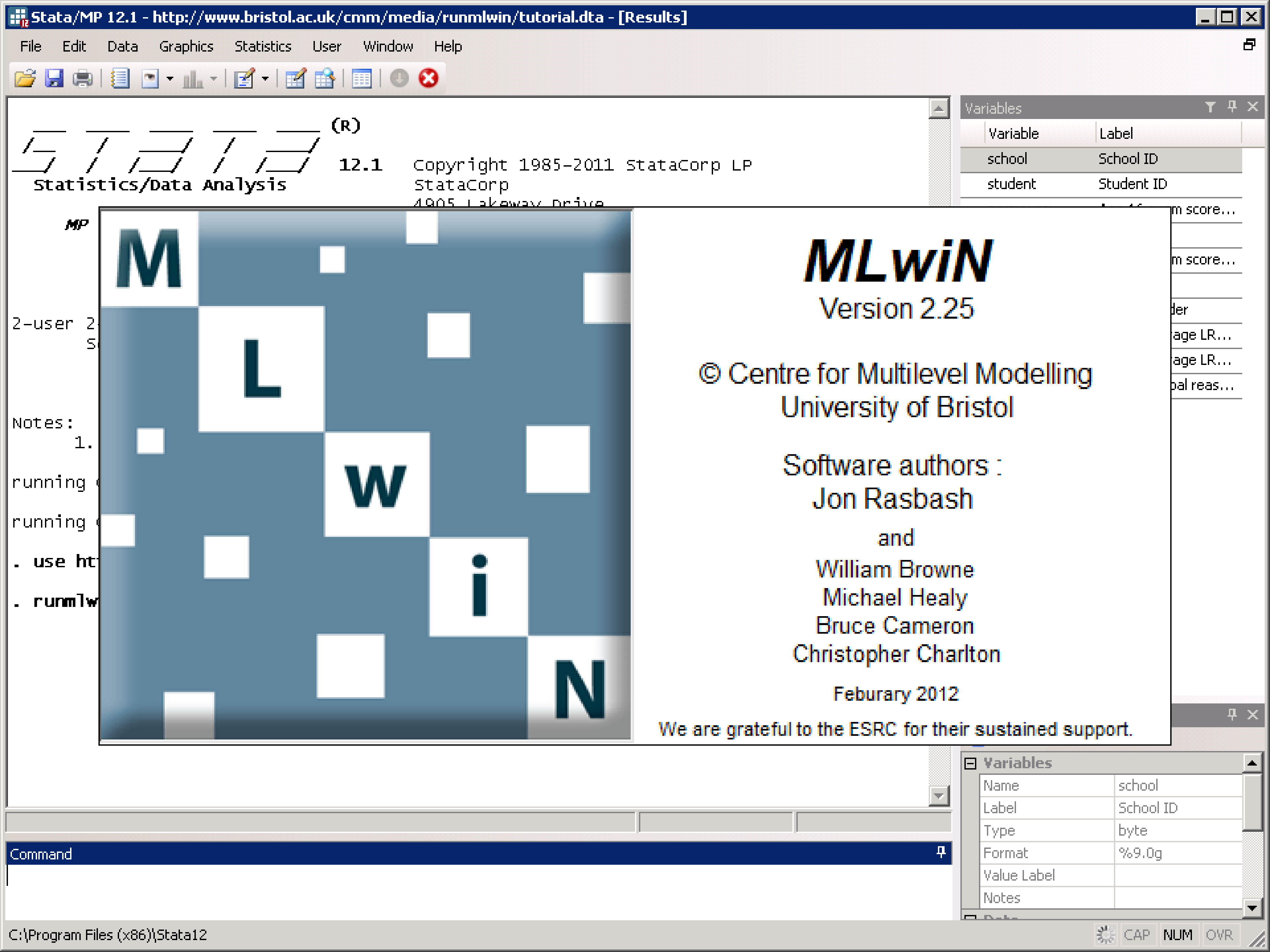
$$u_j \sim \mathrm{N}(0, \sigma_u^2)$$

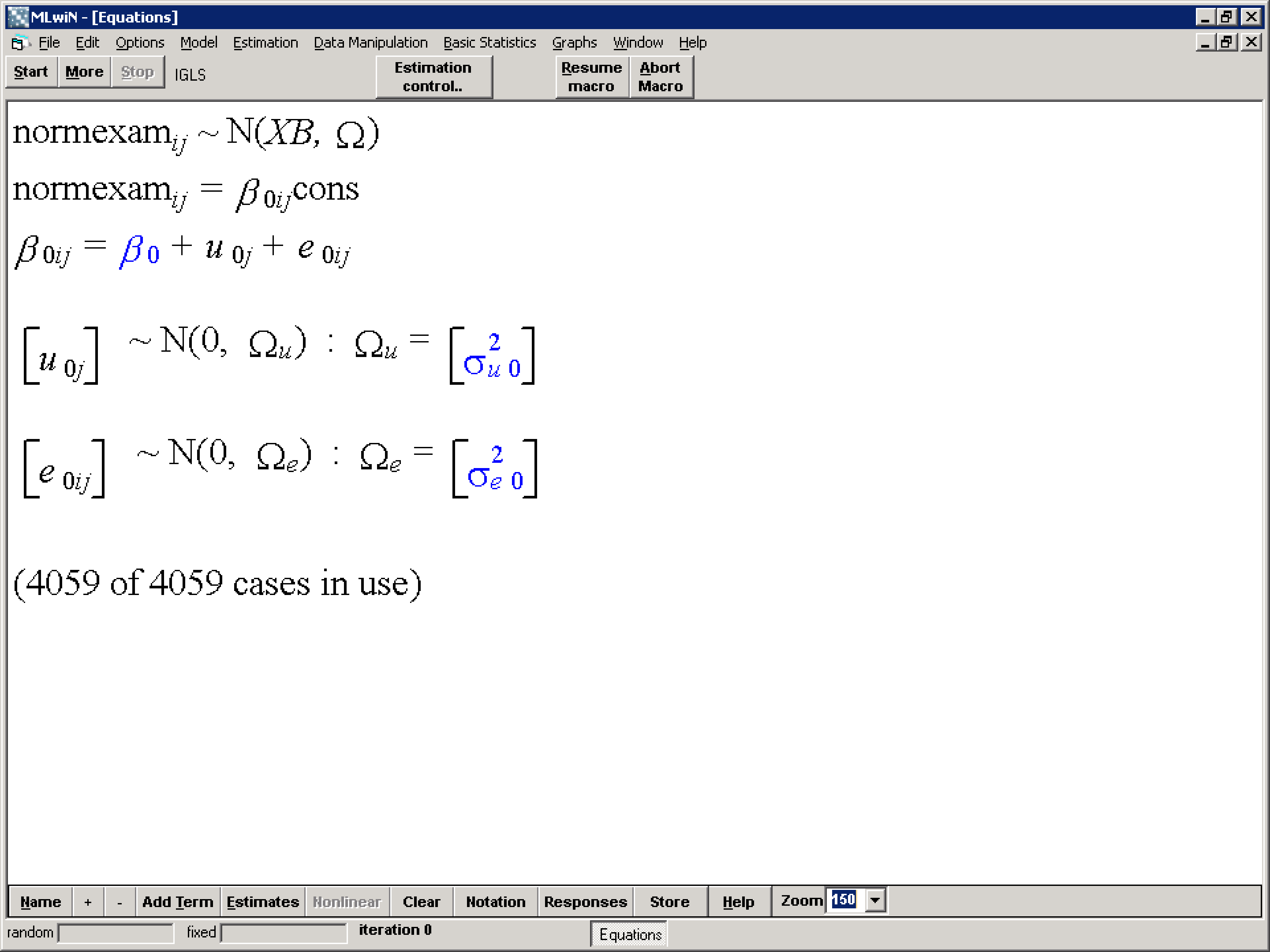
$$e_{ij} \sim \mathrm{N}(0, \sigma_e^2)$$

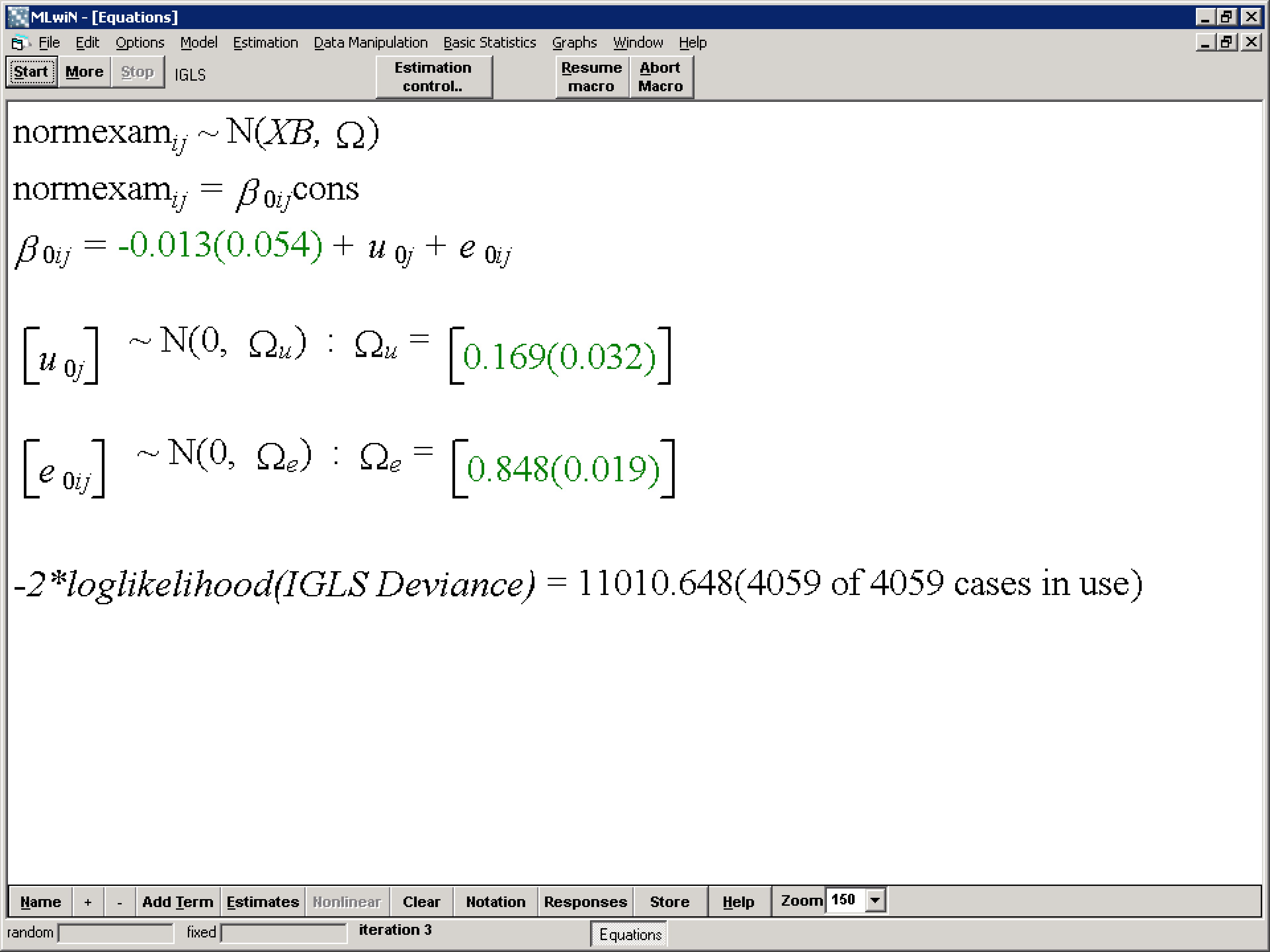
```
. runmlwin normexam cons, ///
      level2(school: cons) ///
      level1(student: cons)
```

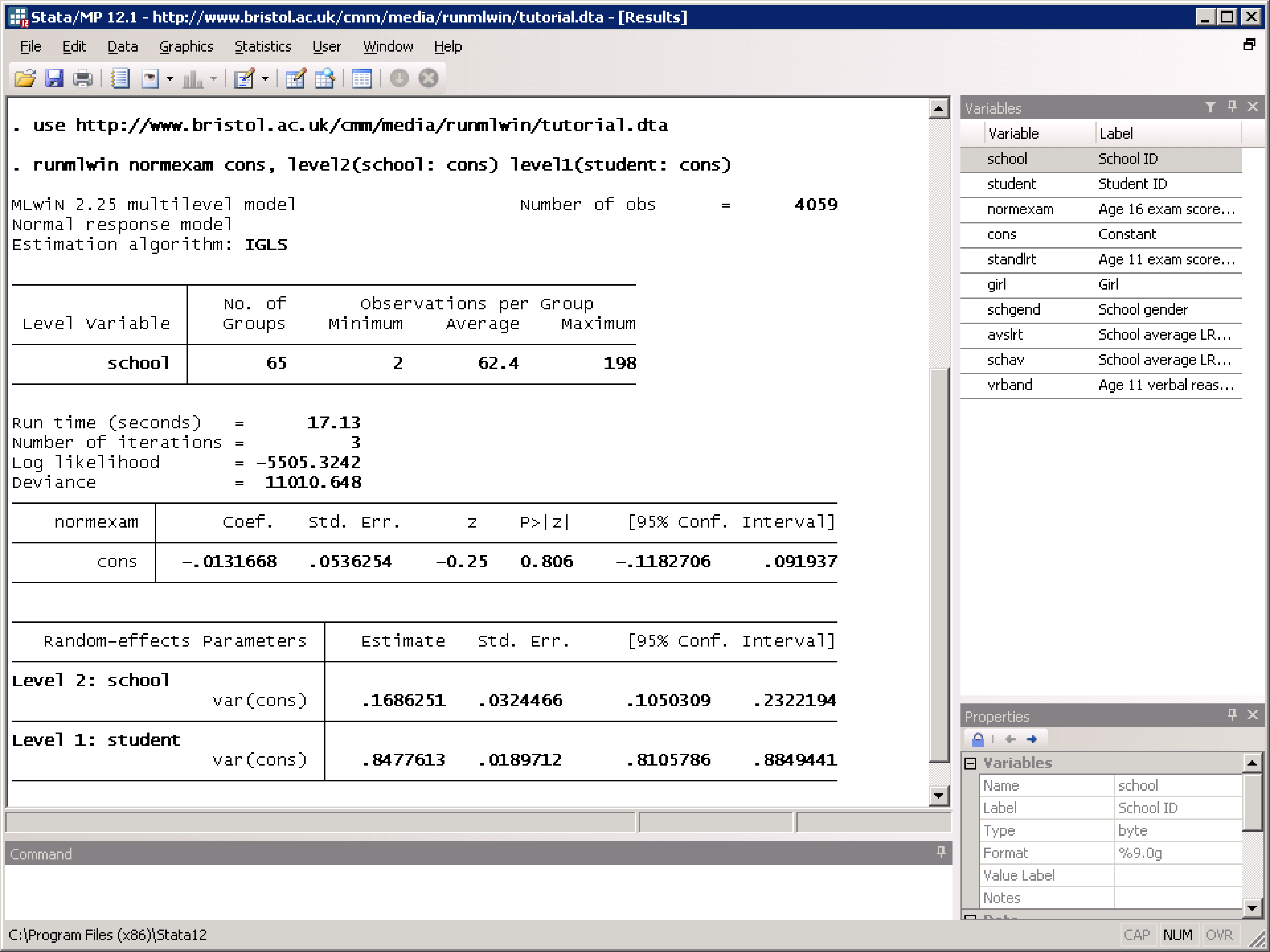


Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]
File Edit Data Graphics Statistics User Window Help
(R)
12.1 Copyright 1985-2011 StataCorp LP
Statistics/Data Analysis
StataCorp
4905 Lakeway Drive
MP - Parallel Edition
College Station, Texas 77845 USA
800-STATA-PC 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 ...
. use http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta
.
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
runmlwin normexam cons, level2(school: cons) level1(student: cons)
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)
12.1 Copyright 1985-2011 StataCorp LP
Statistics/Data Analysis
StataCorp
MP
2-user
Notes:
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
student
Student ID
Variables
Name
school
Label
School ID
Type
byte
Format
%9.0g
Value Label
Notes
Command
C:\Program Files (x86)\Stata12
CAP
NUM
OVR


MLwiN - [Equations]
File Edit Options Model Estimation Data Manipulation Basic Statistics Graphs Window Help
Start More Stop IGLS
Estimation control..
Resume macro
Abort Macro
$\text{normexam}_{ij} \sim \mathrm{N}(XB,\ \Omega)$
$\text{normexam}_{ij} = \beta_{0ij}\text{cons}$
$\beta_{0ij} = \beta_0 + u_{0j} + e_{0ij}$
$\left[u_{0j}\right] \sim \mathrm{N}(0,\ \Omega_u)\ :\ \Omega_u = \left[\sigma^2_{u0}\right]$
$\left[e_{0ij}\right] \sim \mathrm{N}(0,\ \Omega_e)\ :\ \Omega_e = \left[\sigma^2_{e0}\right]$
(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


Stata/MP 12.1 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]
File Edit Data Graphics Statistics User Window Help
. 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
Level Variable | No. of Groups | Observations per Group 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
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

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
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
------------------------------------------------------------------------------
```

C:\Program Files (x86)\Stata12 CAP NUM OVR

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

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

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

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

```
. 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

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

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

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

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

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

C:\Program Files (x86)\Stata12 CAP NUM OVR

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

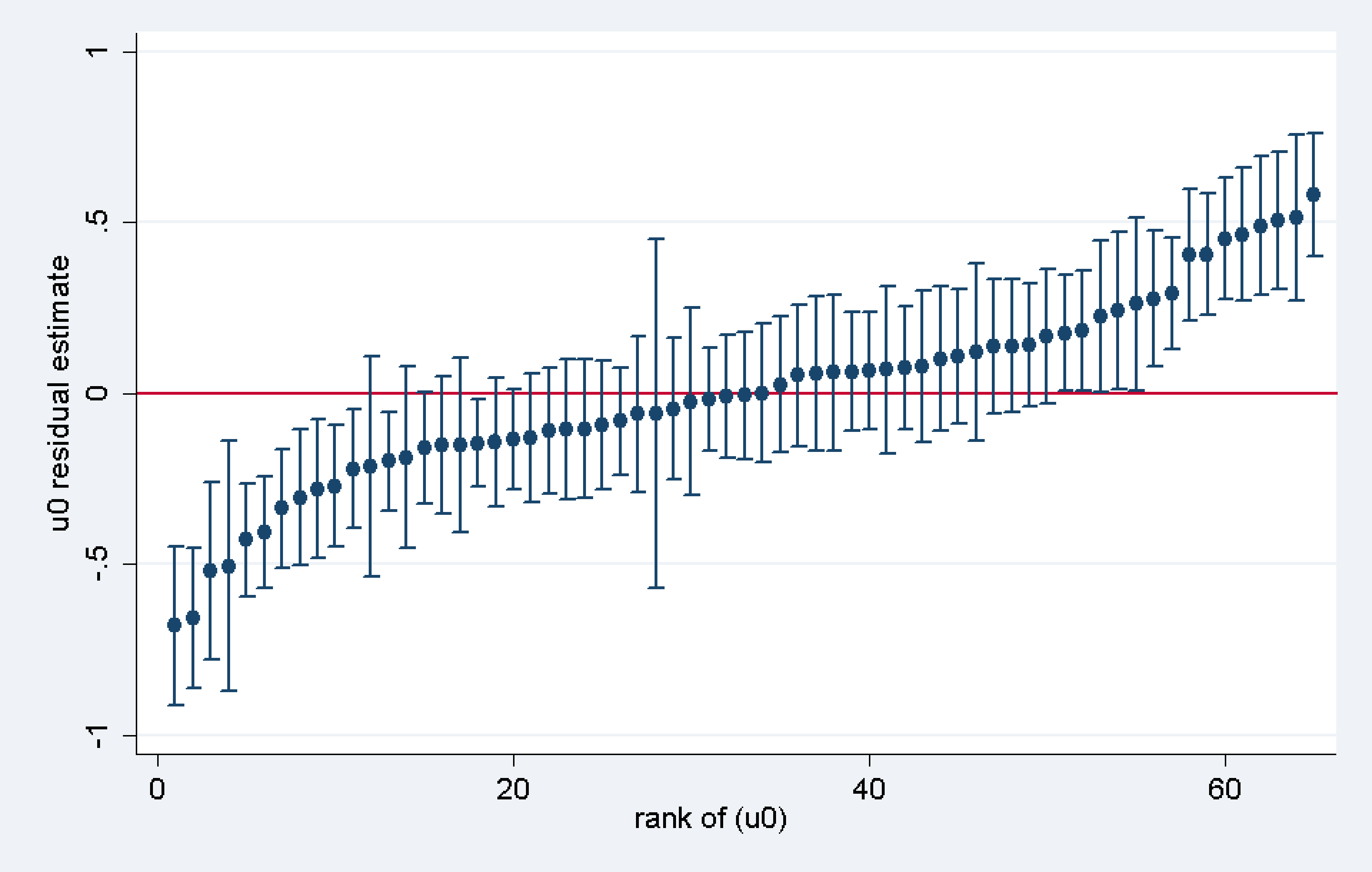
File Edit Data Graphics Statistics User Window Help

```
.
. 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
------------------------------------------------------------------------------
```

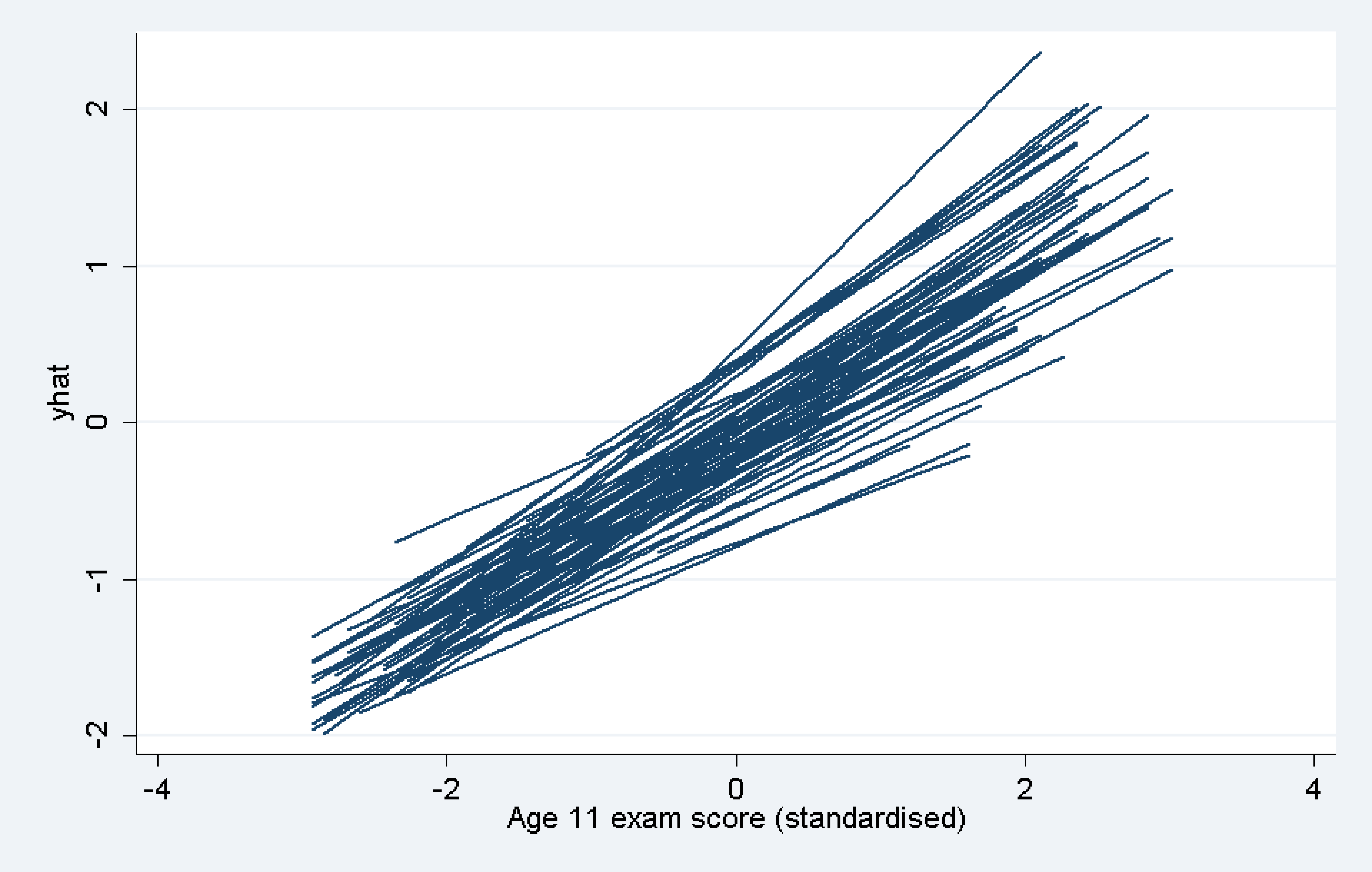
Variables

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]

File Edit Data Graphics Statistics User Window Help

```
. 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. BINARY RESPONSE MODELS

Random slope logistic model

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

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

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

```
. 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

```
.
.
```

C:\Program Files (x86)\Stata12 CAP NUM OVR

Fit model by PQL2 using MQL1 estimates as starting values

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

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

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

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

.
.
```

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

```
.
. 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

```
.
.
.
.
.
```

C:\Program Files (x86)\Stata12 CAP NUM OVR

3. 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

4. MCMC ESTIMATION

Random slope logistic model

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

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

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

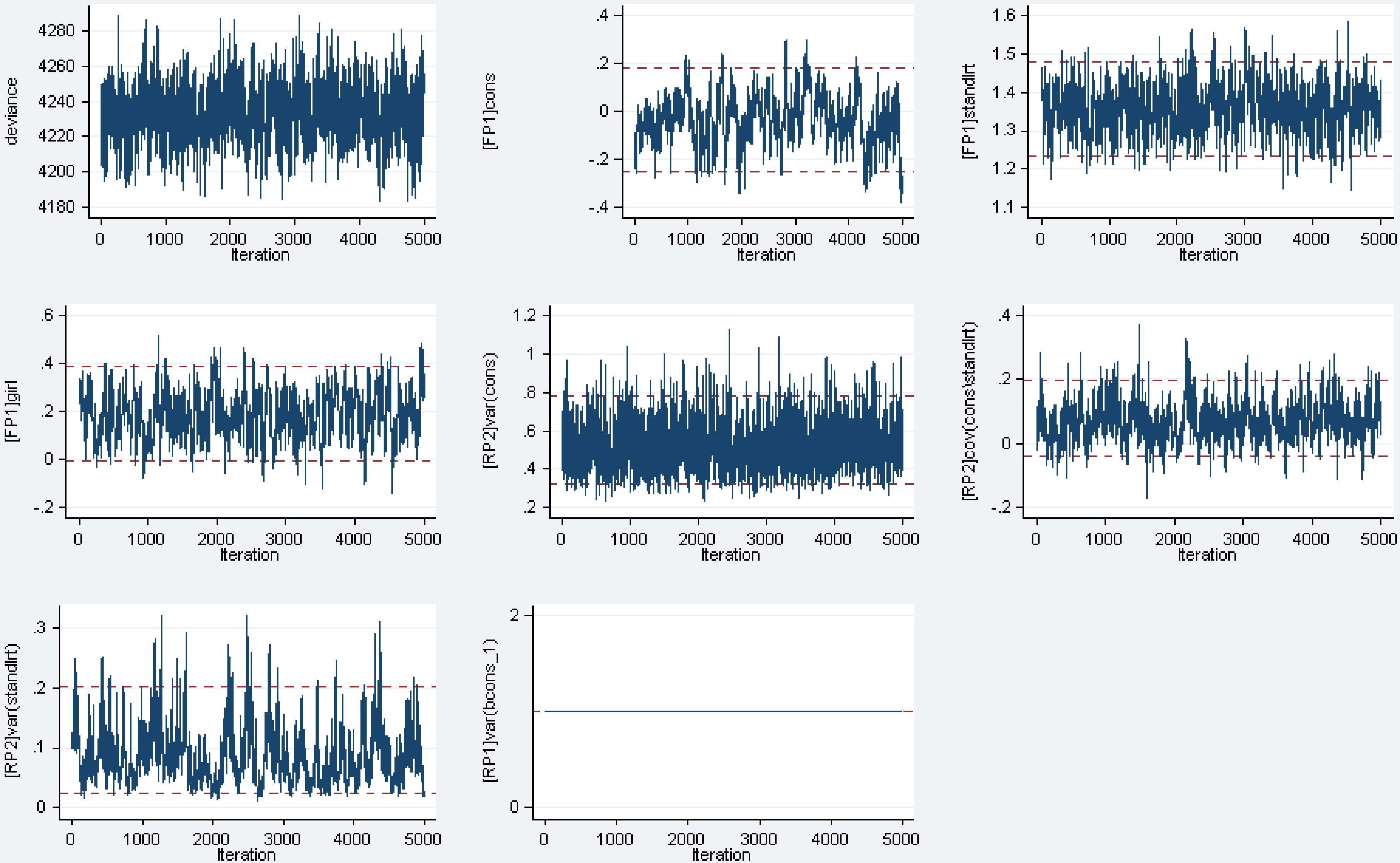
```
. runmlwin passexam cons standlrt girl, ///
      level2(school: cons standlrt) ///
      level1(student:) ///
      discrete(d(binomial) l(logit) de(cons)) ///
      mcmc(burnin(500) chain(5000)) ///
      initsprevious nogroup nopause
```

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

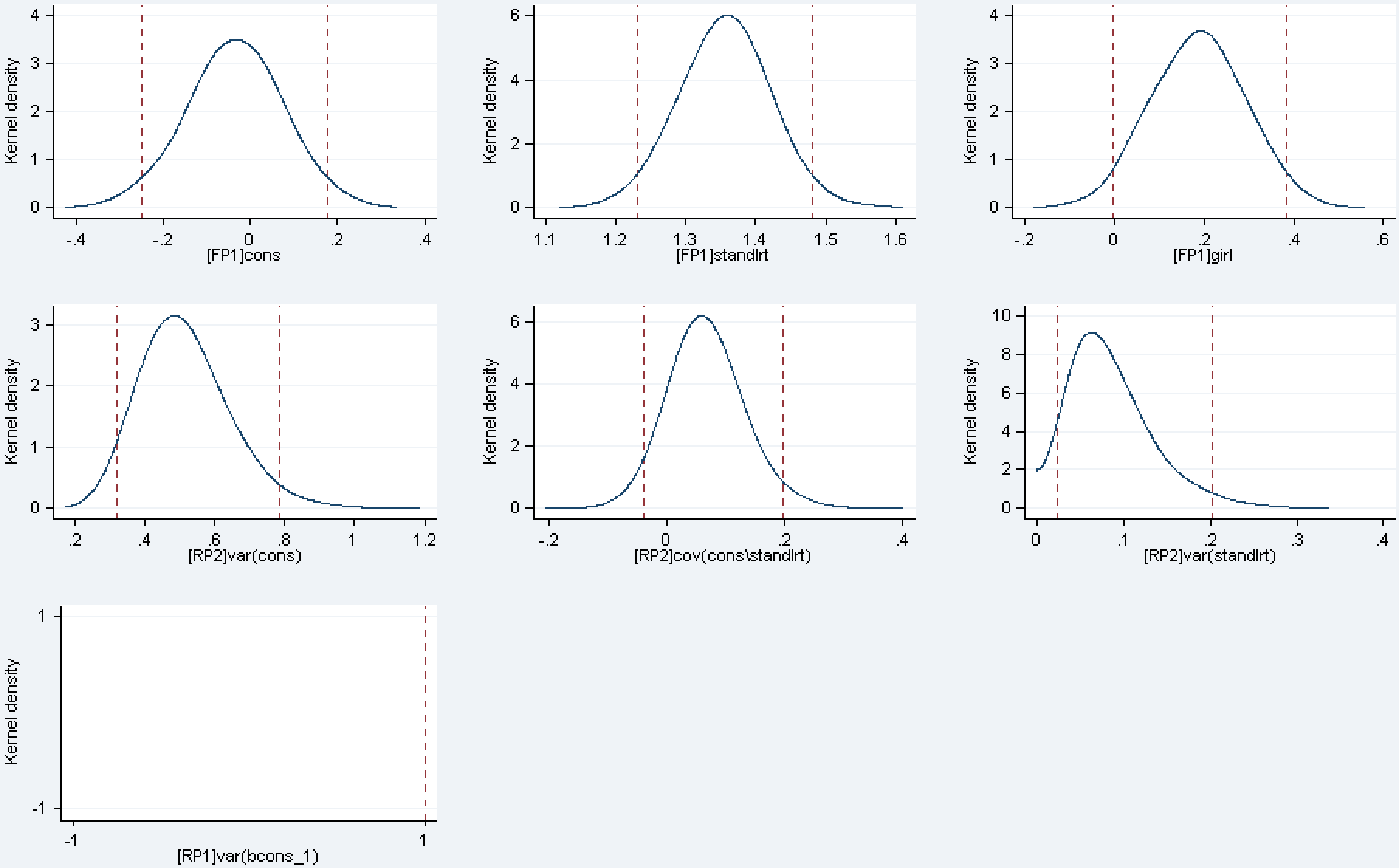
File Edit Data Graphics Statistics User Window Help

```
.
. 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
------------------------------------------------------------------------------
```

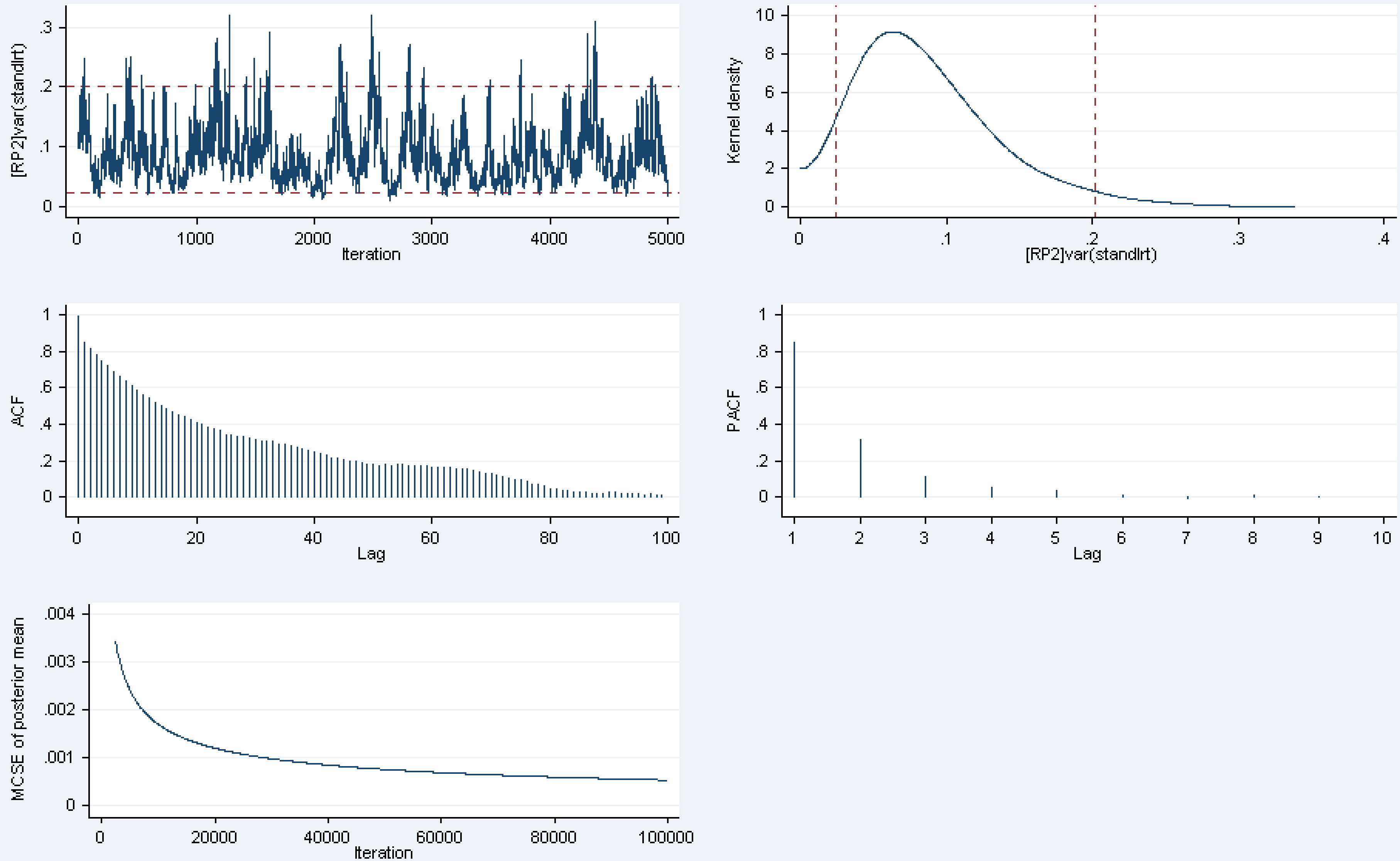
C:\Program Files (x86)\Stata12 CAP NUM OVR




```
. 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
-------------------------------------------------------------------------------

.
.
.
.
.
.
.
.
.
.
.
.
.
.
```

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

```
. 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
------------------------------------------------------------------------------

.
.
```

C:\Program Files (x86)\Stata12 CAP NUM OVR

5. 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

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

6. STATA MAKES IT EASY TO WORK EFFICIENTLY

Do-file Editor - oxford.do

File Edit Tools View

oxford.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: 77, Col: 2 CAP NUM OVR

7. RESOURCES TO HELP YOU LEARN `runmlwin`

Viewer - help runmlwin

File Edit History Help

help runmlwin

help runmlwin X

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*]

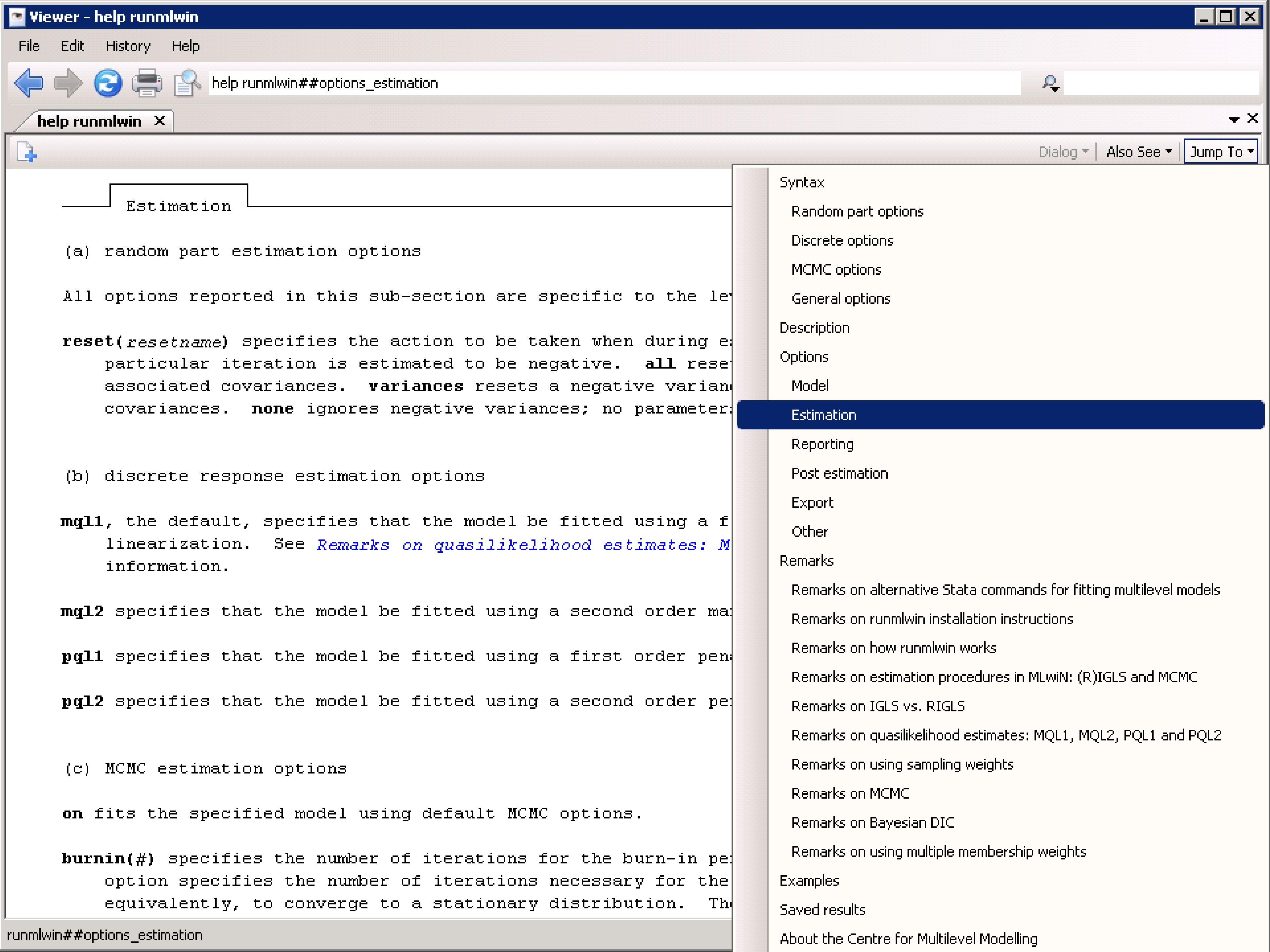
for univariate ordered and unordered categorical response models

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

Bristol University | Centre for Multilevel Modelling | runmlwin: Running MLwiN from within Stata - Mozilla Firefox

File Edit View History Bookmarks Tools Help

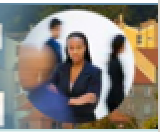
www.bristol.ac.uk/cmm/software/runmlwin/

Google

Bristol University | Centre for Multilevel Mod...

University of BRISTOL

Centre for Multilevel Modelling



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)

Presentations

We have provided a range of presentations showcasing **runmlwin**. These presentations provide a quick overview of how the command works and the range of models which can be fitted. More > >

Installation

SOFTWARE
- MLwiN
- Realcom
- MLPowSim
- runmlwin
  - Presentations
  - Examples
  - Citations
  - User Forum
- CMM software support

University home > Centre for Multilevel Modelling... > Software > runmlwin > Presentations

Presentations using runmlwin

- 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)
  - Slides (PDF, 2.0mb)
  - Stata do-file (do, 0.1mb) to replicate all analyses presented in the slides.
- University of Bristol, e-Stat meeting (7th April 2011)

SOFTWARE
- MLwiN
- Realcom
- MLPowSim
- runmlwin
- Presentations
- Examples
- Citations
- User Forum
- CMM software support

University home > Centre for Multilevel Modelling... > Software > runmlwin > Examples

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)
- 10 Multinomial Logistic Models for Unordered Categorical Responses (do | log)
- 11 Fitting an Ordered Category Response Model (do | log)
- 12 Modelling Count Data (do | log)
- 13 Fitting Models to Repeated Measures Data (do | log)
- 14 Multivariate Response Models (do | log)

runmlwin user forum

Forum rules

NEWTOPIC Search this forum... Search

Mark topics read • 85 topics • Page 1 of 4 • 1 2 3 4

ANNOUNCEMENTS	REPLIES	VIEWS	LAST POST
runmlwin has had 1300+ downloads since Oct 2011 by GeorgeLeckie » Tue May 15, 2012 8:00 pm	0	315	by GeorgeLeckie Tue May 15, 2012 8:00 pm
Make sure you have latest version of runmlwin: 16/04/2012 by GeorgeLeckie » Tue May 01, 2012 4:21 pm	0	329	by GeorgeLeckie Tue May 01, 2012 4:21 pm
Do-files to replicate entire MLwiN User & MCMC Manuals by GeorgeLeckie » Mon Apr 18, 2011 5:30 pm	7	967	by GeorgeLeckie Tue Mar 13, 2012 3:47 pm
Welcome to the runmlwin discussion forum by GeorgeLeckie » Fri Apr 01, 2011 4:06 pm	0	572	by GeorgeLeckie Fri Apr 01, 2011 4:06 pm

TOPICS	REPLIES	VIEWS	LAST POST
Errors in estimating 2-level model with random slopes by Jacqueline » Wed Jun 27, 2012 5:08 pm	1	5	by GeorgeLeckie Wed Jun 27, 2012 5:51 pm
Predicted probabilities after multilevel logit model by Raphael » Sun Jun 24, 2012 10:08 pm	4	15	by Raphael Wed Jun 27, 2012 3:37 pm
Error fitting Multinomial logit using PQL2 by jmflavel » Mon Jun 18, 2012 6:45 am	4	29	by GeorgeLeckie Mon Jun 25, 2012 6:25 pm
Errors fitting cross-classified logistic model by MCMC by rebvas86 » Wed May 30, 2012 2:46 pm	6	898	by GeorgeLeckie Thu Jun 14, 2012 11:29 am
DIC statistic for multinomial random effects model by bogdan2012 » Mon Jun 04, 2012 9:35 pm	1	263	by GeorgeLeckie Tue Jun 05, 2012 9:40 am
Getting p-values and z-ratios after MCMC by AnjaScheiwe » Tue May 22, 2012 11:49 am	4	373	by AnjaScheiwe Tue May 22, 2012 2:09 pm
Re: Residuals for multi-level logistic model in runmlwin by DavidPopMed » Mon May 14, 2012 7:03 pm	1	249	by GeorgeLeckie Mon May 14, 2012 7:29 pm
Problem getting residuals: after merge, not all observations by ewancarr » Tue May 01, 2012 9:34 pm 1 2	10	566	by ewancarr Thu May 03, 2012 7:09 pm
discrete time multilevel event history model			by ChrisCharlton