# Running MLwiN from within Stata: the `runmlwin` command

## Modern Modeling Methods (M3) Conference
## University of Connecticut
## 26th May 2011

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Centre for Multilevel Modelling

University of Bristol

# INTRODUCTION

# Existing multilevel modelling commands in Stata

- Stata provide the `xtmixed`, `xtmelogit` and `xtmepoisson` commands to fit multilevel models
  - Limited range of models can be specified
  - Computationally quite slow to fit models
- Sophia Rabe-Hesketh and Anders Skrondal provide the `gllamm` command
  - Wide range of models can be specified
  - Computationally slow to fit models
- Other user-written multilevel modelling commands include: `hlm`, `realcomimpute`, `runmplus`, `sabre`, `winbugs`

# Multilevel modelling in MLwiN

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

2. Constraints allowing models such as the social relations models and behavioural genetics models to be formulated as multilevel models

3. Fast estimation via classical and Bayesian methods

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

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

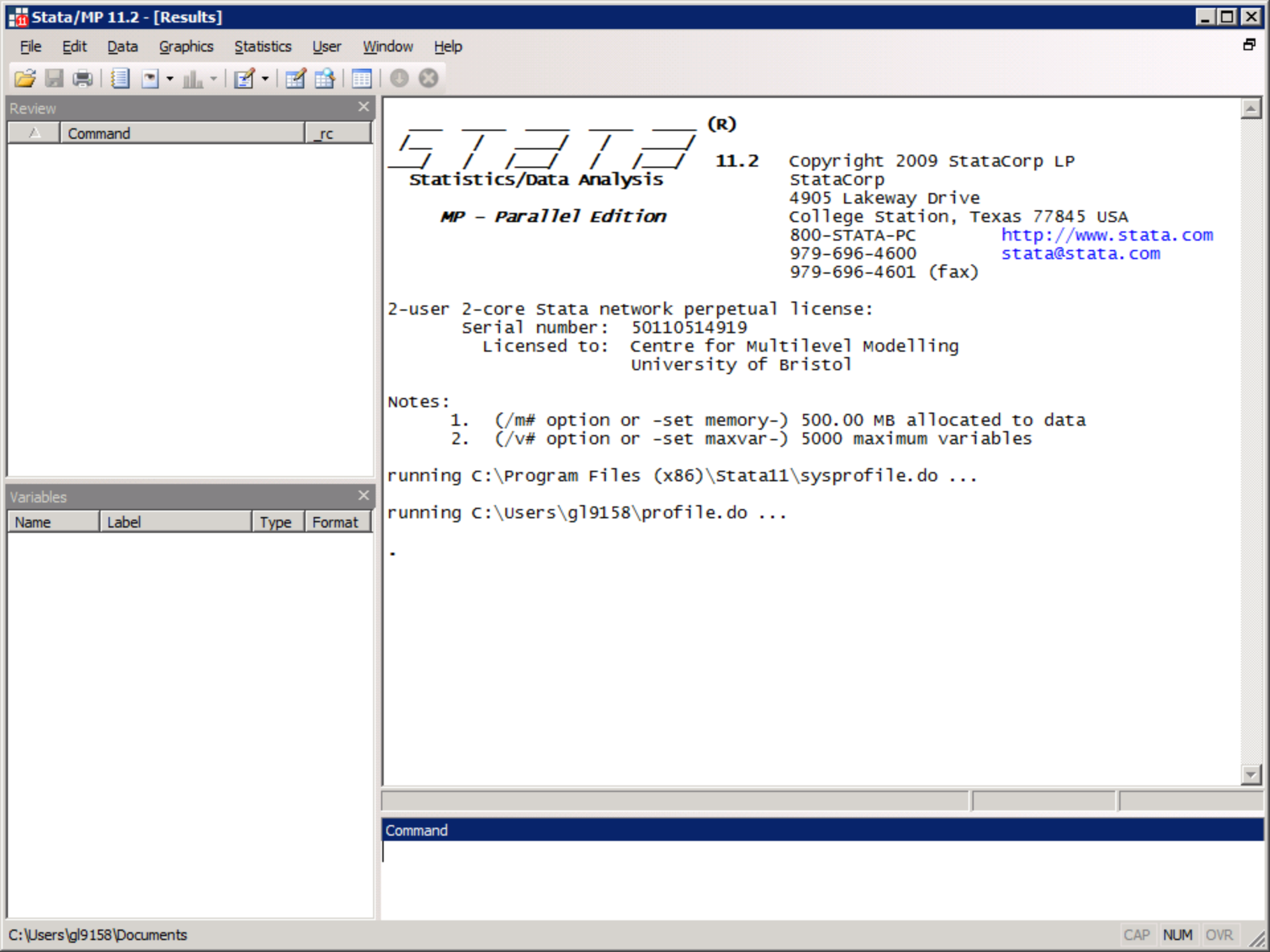
# Examples

1. Two-level multilevel model
2. Growth curve models
3. Multilevel models for binary responses
4. Simulation studies are easy
5. MCMC estimation
6. Cross-classified models
7. Spatial multilevel models
8. Export models to WinBUGS
9. Work efficiently
10. Resources to help you learn `runmlwin`

# 1. TWO-LEVEL MULTILEVEL MODELS

# Two-level variance components model

- Inner-London schools exam scores data set
- Classic MLwiN User Manual example
- First analysed by Goldstein et al. (1993)
- Reanalysed by Goldstein (2010), Rabe-Hesketh and Skrondal (2008), Rasbash et al. (2009) and others
- 4059 students nested within 65 schools


Stata/MP 11.2 - [Results]
File Edit Data Graphics Statistics User Window Help
Review
Command _rc
Variables
Name Label Type Format
(R)
11.2
Statistics/Data Analysis
MP - Parallel Edition
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Notes:
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2. (/v# option or -set maxvar-) 5000 maximum variables
running C:\Program Files (x86)\Stata11\sysprofile.do ...
running C:\Users\gl9158\profile.do ...
.
Command
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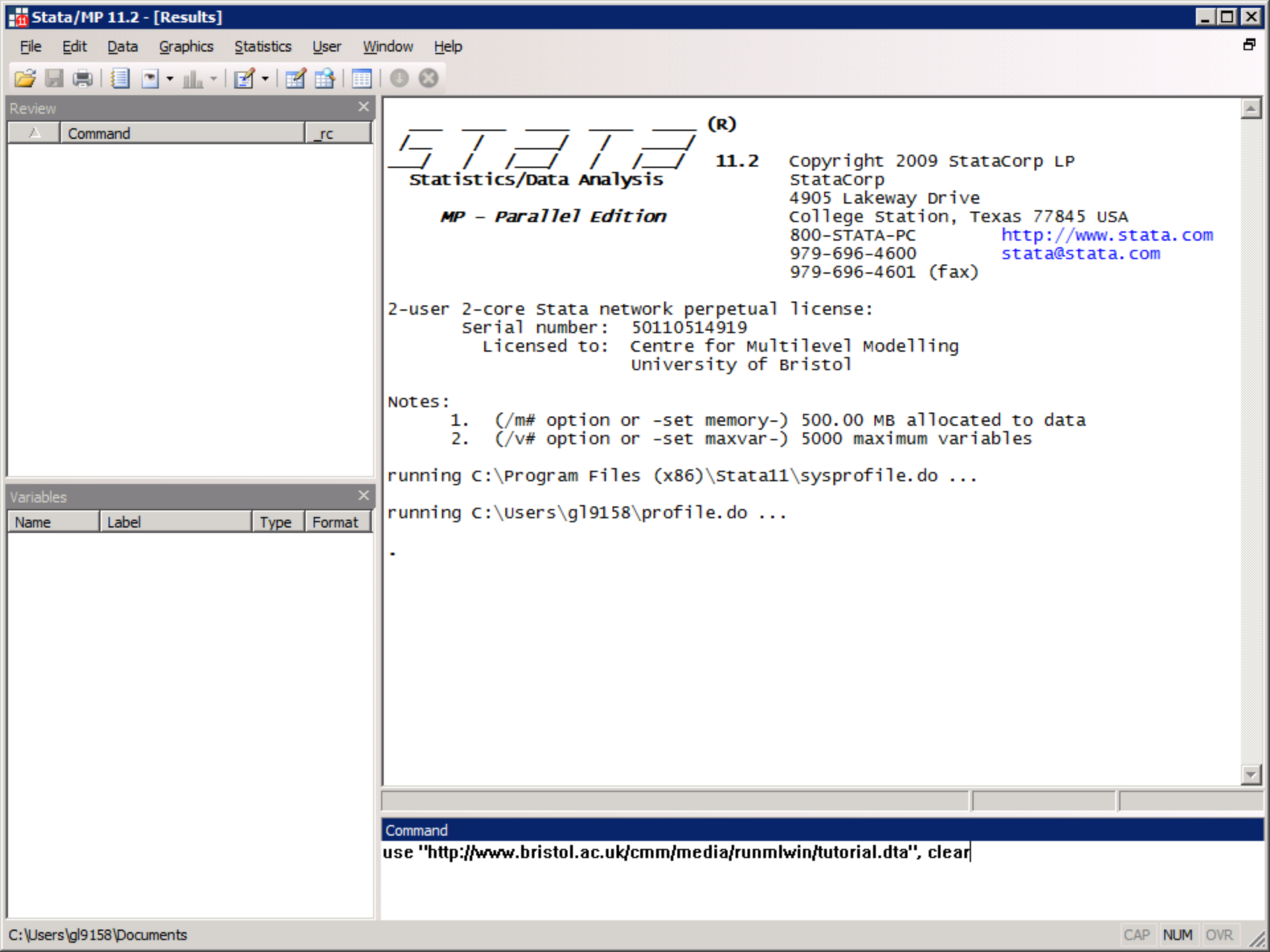
Stata/MP 11.2 - [Results]
File Edit Data Graphics Statistics User Window Help
Review
Command _rc
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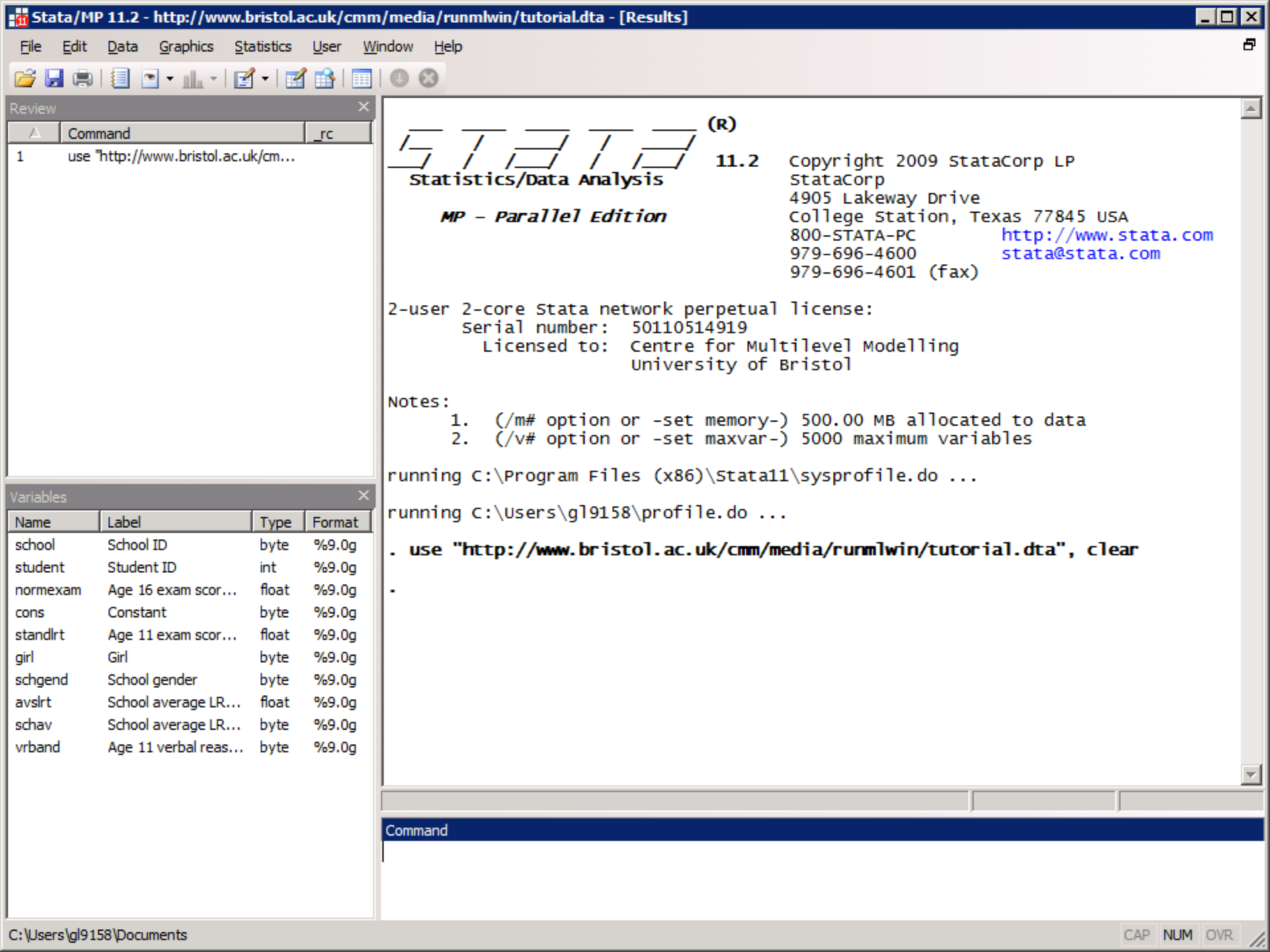
running C:\Program Files (x86)\Stata11\sysprofile.do ...
running C:\Users\gl9158\profile.do ...
.
Command
use "http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta", clear
C:\Users\gl9158\Documents
CAP NUM OVR


Stata/MP 11.2 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]
File Edit Data Graphics Statistics User Window Help
Review
Command _rc
1 use "http://www.bristol.ac.uk/cm...
Variables
Name Label Type Format
school School ID byte %9.0g
student Student ID int %9.0g
normexam Age 16 exam scor... float %9.0g
cons Constant byte %9.0g
standlrt Age 11 exam scor... float %9.0g
girl Girl byte %9.0g
schgend School gender byte %9.0g
avslrt School average LR... float %9.0g
schav School average LR... byte %9.0g
vrband Age 11 verbal reas... byte %9.0g
(R)
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. use "http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta", clear
.
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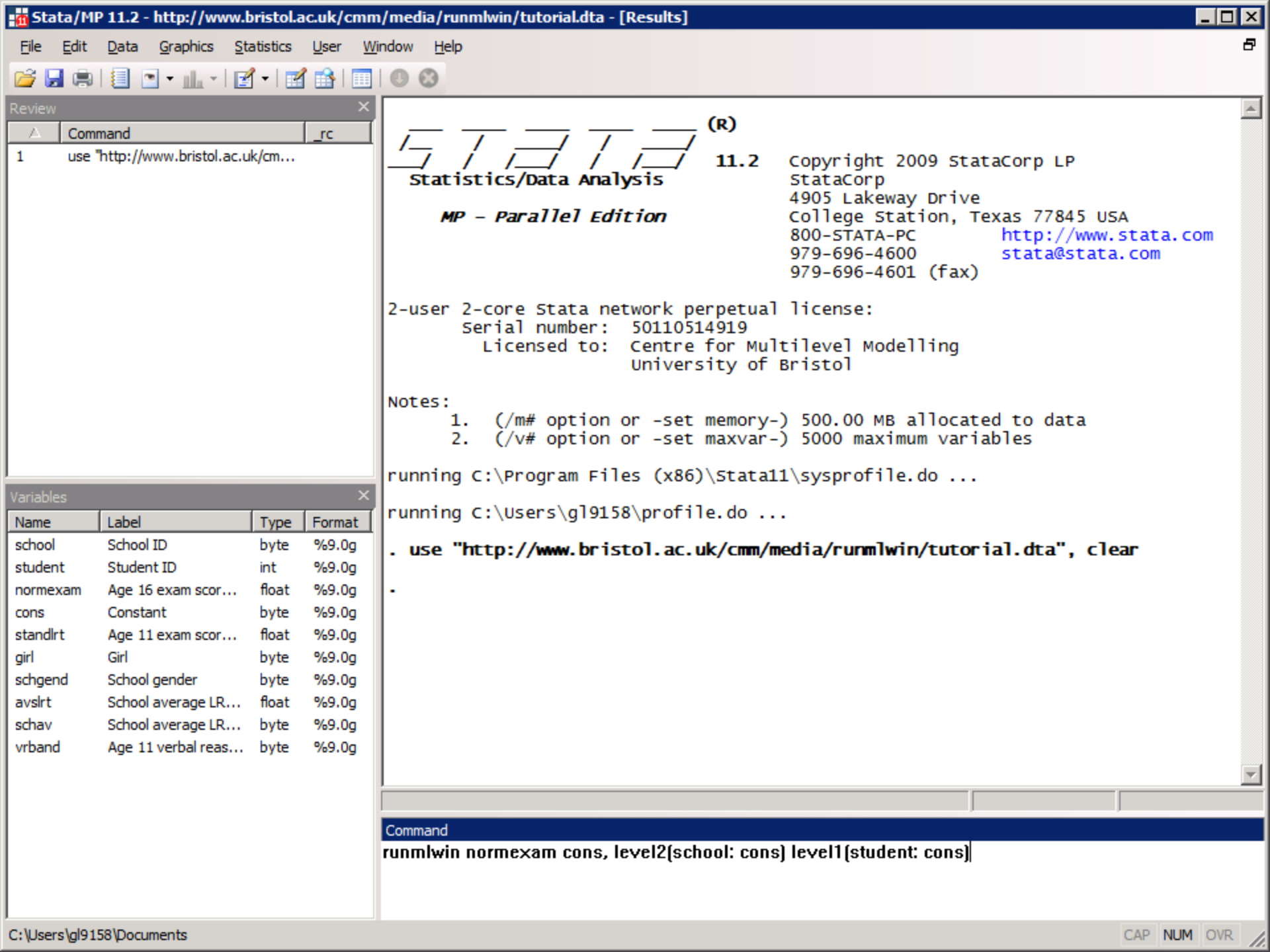
# The `runmlwin` command syntax

$$normexam_{ij} = \beta_0 + u_j + e_{ij}$$

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

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

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


Stata/MP 11.2 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]
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Command _rc
1 use "http://www.bristol.ac.uk/cm...
Variables
Name Label Type Format
school School ID byte %9.0g
student Student ID int %9.0g
normexam Age 16 exam scor... float %9.0g
cons Constant byte %9.0g
standlrt Age 11 exam scor... float %9.0g
girl Girl byte %9.0g
schgend School gender byte %9.0g
avslrt School average LR... float %9.0g
schav School average LR... byte %9.0g
vrband Age 11 verbal reas... byte %9.0g
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. use "http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta", clear
.
Command
runmlwin normexam cons, level2(school: cons) level1(student: cons)
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File Edit Data Graphics Statistics User Window Help

Review

| | Command | _rc |
|---|---|---|
| 1 | use "http://www.bristol.ac.uk/cm... | |
| 2 | runmlwin normexam cons, level2(... | |

Variables

| Name |
|---|
| school |
| student |
| normexam |
| cons |
| standlrt |
| girl |
| schgend |
| avslrt |
| schav |
| vrband |

(R)
Statistics/Data Analysis
11.2
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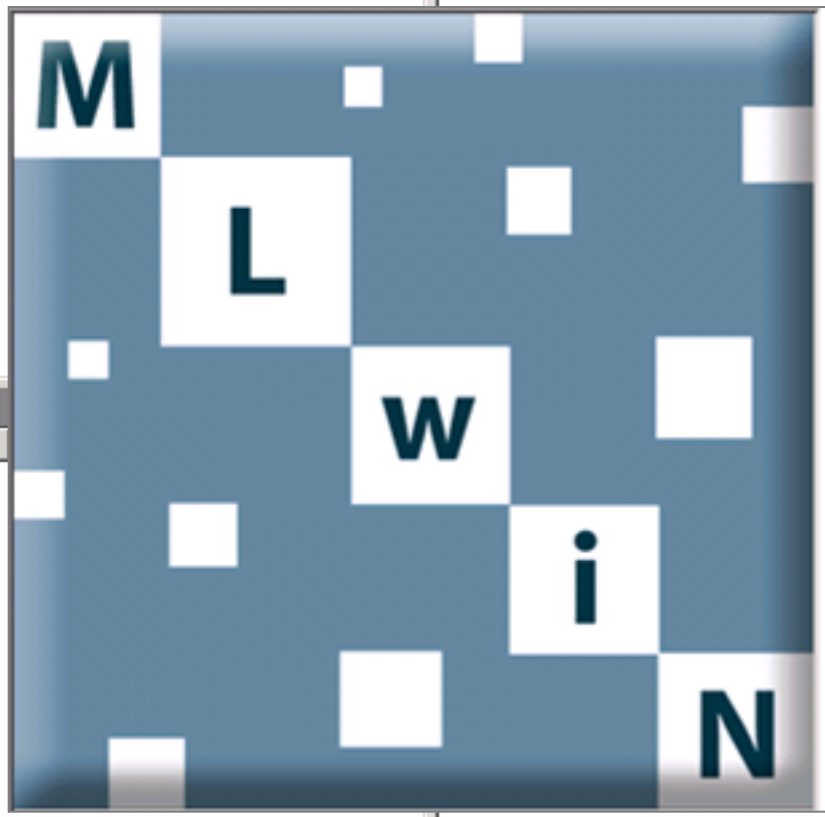


**MLwiN**
Version 2.23

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University of Bristol

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

March 2011

We are grateful to the ESRC for their sustained support.

Command

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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
$\text{normexam}_{ij} \sim \text{N}(XB, \Omega)$
$\text{normexam}_{ij} = \beta_{0ij}\text{cons}$
$\beta_{0ij} = \beta_0 + u_{0j} + e_{0ij}$
$\begin{bmatrix} u_{0j} \end{bmatrix} \sim \text{N}(0, \Omega_u) : \Omega_u = \begin{bmatrix} \sigma^2_{u0} \end{bmatrix}$
$\begin{bmatrix} e_{0ij} \end{bmatrix} \sim \text{N}(0, \Omega_e) : \Omega_e = \begin{bmatrix} \sigma^2_{e0} \end{bmatrix}$
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
$\text{normexam}_{ij} \sim \text{N}(XB, \Omega)$
$\text{normexam}_{ij} = \beta_{0ij}\text{cons}$
$\beta_{0ij} = -0.013(0.054) + u_{0j} + e_{0ij}$
$\left[u_{0j}\right] \sim \text{N}(0, \Omega_u) : \Omega_u = \left[0.169(0.032)\right]$
$\left[e_{0ij}\right] \sim \text{N}(0, \Omega_e) : \Omega_e = \left[0.848(0.019)\right]$
-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 11.2 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

File Edit Data Graphics Statistics User Window Help

Review

| | Command | _rc |
|---|---|---|
| 1 | use "http://www.bristol.ac.uk/cm... | |
| 2 | runmlwin normexam cons, level2(... | |

Variables

| Name | Label | Type | Format |
|---|---|---|---|
| school | School ID | byte | %9.0g |
| student | Student ID | int | %9.0g |
| normexam | Age 16 exam scor... | float | %9.0g |
| cons | Constant | byte | %9.0g |
| standlrt | Age 11 exam scor... | float | %9.0g |
| girl | Girl | byte | %9.0g |
| schgend | School gender | byte | %9.0g |
| avslrt | School average LR... | float | %9.0g |
| schav | School average LR... | byte | %9.0g |
| vrband | Age 11 verbal reas... | byte | %9.0g |

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

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

MLwiN 2.23 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)   =      12.93
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:** | var(cons) | **.1686251** | **.0324466** | **.1050309** | **.2322194** |
| **Level 1:** | var(cons) | **.8477613** | **.0189712** | **.8105786** | **.8849441** |

```
.
```

Command

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Stata/MP 11.2 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

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

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

MLwiN 2.23 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)   =      12.93
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:** | var(cons) | .1686251 | .0324466 | .1050309 | .2322194 |
| **Level 1:** | var(cons) | .8477613 | .0189712 | .8105786 | .8849441 |

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CAP NUM OVR

# Retrieve the level 2 residuals

$$normexam_{ij} = \beta_0 + u_j + e_{ij}$$

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

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

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

# Do not pause in MLwiN

$$normexam_{ij} = \beta_0 + u_j + e_{ij}$$

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

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

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

Stata/MP 11.2 - 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, residuals(u)) level1(student: cons) nopause

MLwiN 2.23 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)    =      1.47
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:** | var(cons) | .1686251 | .0324466 | .1050309 | .2322194 |
| **Level 1:** | var(cons) | .8477613 | .0189712 | .8105786 | .8849441 |

```
.
```

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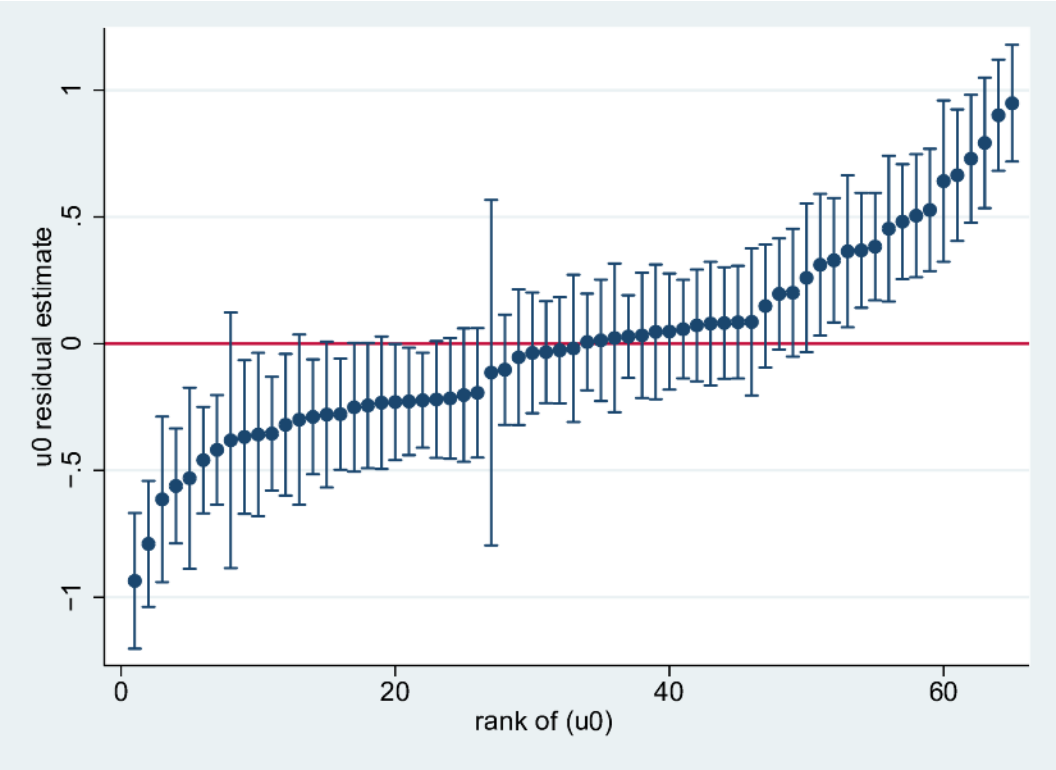
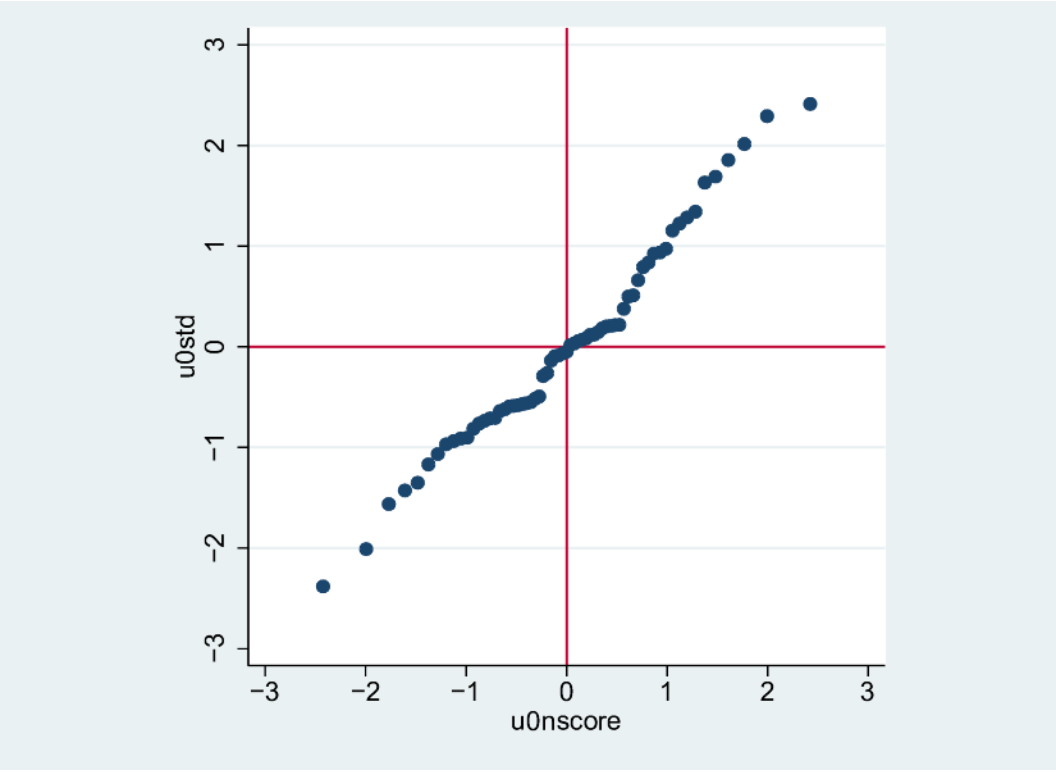



```
. egen u0rank = rank(u0)

. serrbar u0 u0se u0rank, scale(1.96) yline(0)
```




```
. summarize u0

. generate u0std = (u0 - r(mean))/r(sd)

. generate u0uniform = (u0rank - 0.5)/_N

. generate u0nscore = invnorm(u0uniform)

. scatter u0std u0nscore, yline(0) xline(0) ///
      ylabel(-3(1)3) xlabel(-3(1)3) aspectratio(1)
```

# Add covariates

$$normexam_{ij} = \beta_0 + \beta_1 standlrt_{ij} + \beta_2 girl_{ij} + u_j + e_{ij}$$

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

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

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

# Include a random slope

$$normexam_{ij} = \beta_0 + \beta_1 standlrt_{ij} + \beta_2 girl_{ij} + u_{0j} + u_{1j} standlrt_{ij} + e_{ij}$$

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

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

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

# Allow for level 1 heteroskedasticity

$$normexam_{ij} = \beta_0 + \beta_1 standlrt_{ij} + \beta_2 girl_{ij} + u_{0j} + u_{1j} standlrt_{ij}$$

$$+ e_{2ij} girl_{ij} + e_{3ij} boy_{ij}$$

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

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

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

Stata/MP 11.2 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

File Edit Data Graphics Statistics User Window Help

MLwiN 2.23 multilevel model
Normal response model
Estimation algorithm: **IGLS**

Number of obs = **4059**

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

Run time (seconds) = **1.61**
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:** | | | | |
| var(cons) | .0862511 | .017175 | .0525887 | .1199135 |
| cov(cons,standlrt) | .0190537 | .0066789 | .0059632 | .0321441 |
| var(standlrt) | .0148919 | .0044702 | .0061304 | .0236534 |
| **Level 1:** | | | | |
| var(girl) | .5251641 | .0152836 | .4952088 | .5551194 |
| var(boy) | .5874345 | .0209983 | .5462786 | .6285904 |

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

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

           chi2(  1) =    5.74
         Prob > chi2 =    0.0166
```

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# 2. GROWTH CURVE MODELS

# Child weight data

- Weight gain of Asian children in a British community
- 68 children, one to five measurements per child
- First analysed by Goldstein (1986)
- Re-analysed by Rabe-Hesketh and Skrondal (2008) and others

Stata/MP 11.2 - http://www.stata-press.com/data/mlmus2/asian.dta - [Results]

File Edit Data Graphics Statistics User Window Help

Review

| | Command | _rc |
|---|---|---|
| 1 | use "http://www.stata-press.co... | |

Variables

| Name | Label | Type | Format |
|---|---|---|---|
| id | | int | %8.0g |
| occ | | byte | %9.0g |
| age | | float | %8.0g |
| weight | | float | %8.0g |
| brthwt | | int | %8.0g |
| gender | | int | %8.0g |

```
  ___  ____  ____  ____  ____ (R)
 /__    /   ____/   /   ____/
___/   /   /___/   /   /___/   11.2   Copyright 2009 StataCorp LP
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                                      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)

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       Serial number:  50110514919
         Licensed to:  Centre for Multilevel Modelling
                       University of Bristol

Notes:
      1.  (/m# option or -set memory-) 500.00 MB allocated to data
      2.  (/v# option or -set maxvar-) 5000 maximum variables

running C:\Program Files (x86)\Stata11\sysprofile.do ...

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

. use "http://www.stata-press.com/data/mlmus2/asian.dta", clear

.
```

Command

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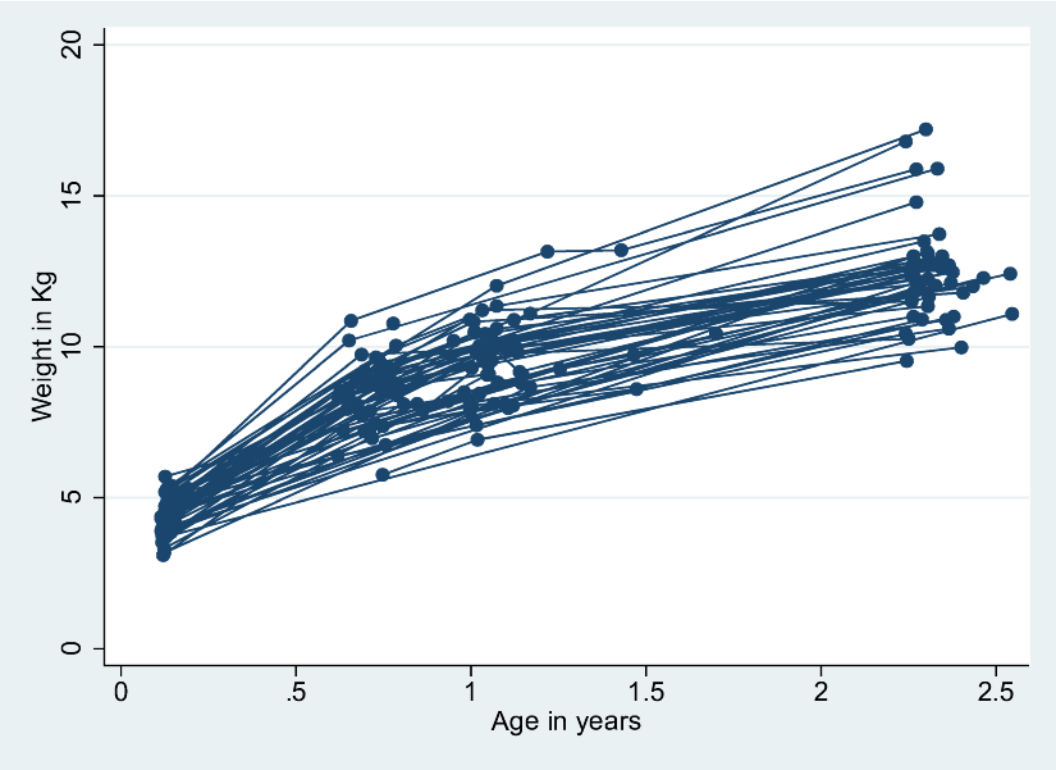


- ```
  graph twoway ///
      (connect weight age, connect(ascending)), ///
      ytitle("Weight in Kg") xtitle("Age in years")
  ```
  ```

# Growth curve model

$$weight_{ij} = \beta_0 + \beta_1 age_{ij} + \beta_2 age_{ij}^2 + u_{0j} + u_{1j} age_{ij} + e_{ij}$$

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

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

```
. runmlwin weight cons age age2, ///
      level2(id: cons age, residuals(u)) ///
      level1(occ: cons) nopause
```

Stata/MP 11.2 - http://www.stata-press.com/data/mlmus2/asian.dta - [Results]

File Edit Data Graphics Statistics User Window Help

MLwiN 2.23 multilevel model
Normal response model
Estimation algorithm: **IGLS**

Number of obs = **198**

| Level Variable | No. of Groups | Observations per Group Minimum | Average | Maximum |
|---|---|---|---|---|
| **id** | **68** | **1** | **2.9** | **5** |

Run time (seconds) = **1.62**
Number of iterations = **7**
Log likelihood = **-258.07785**
Deviance = **516.1557**

| weight | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| cons | 3.494518 | .1372489 | 25.46 | 0.000 | 3.225515 | 3.76352 |
| age | 7.704002 | .2394275 | 32.18 | 0.000 | 7.234733 | 8.173271 |
| age2 | -1.660475 | .0885319 | -18.76 | 0.000 | -1.833994 | -1.486955 |

| Random-effects Parameters | Estimate | Std. Err. | [95% Conf. | Interval] |
|---|---|---|---|---|
| **Level 2:** | | | | |
| var(cons) | .4040045 | .1412488 | .1271619 | .6808471 |
| cov(cons,age) | .088273 | .0812774 | -.0710279 | .2475738 |
| var(age) | .2539857 | .0858503 | .0857222 | .4222493 |
| **Level 1:** | | | | |
| var(cons) | .331641 | .0532307 | .2273107 | .4359712 |

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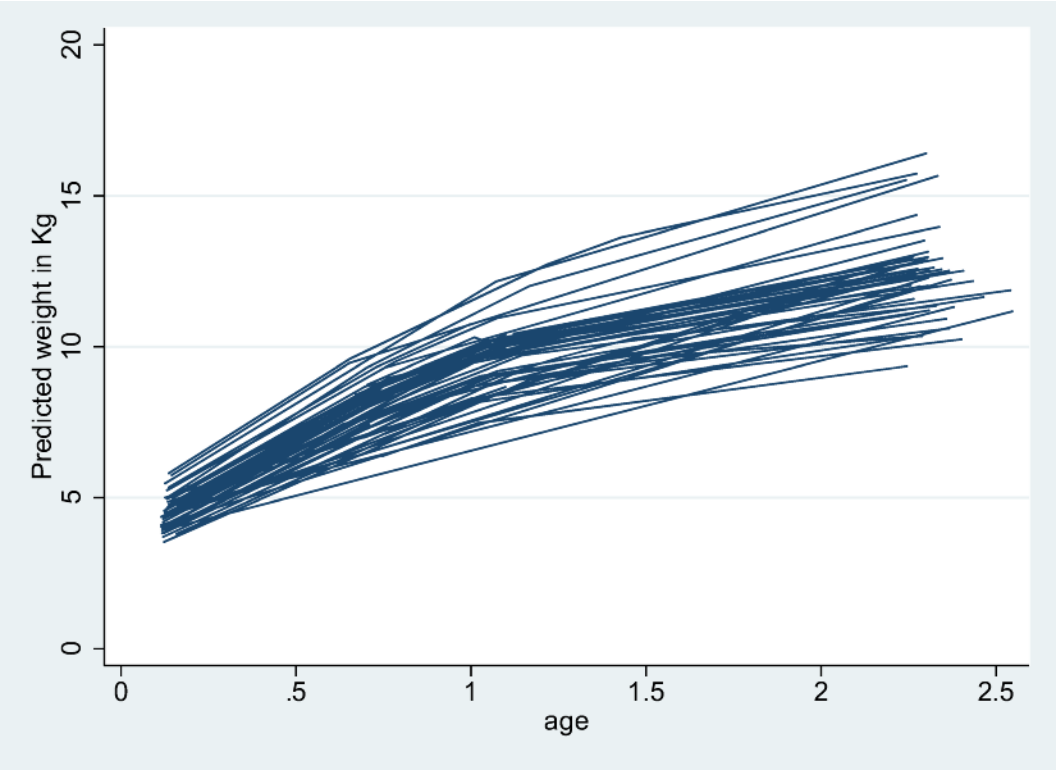
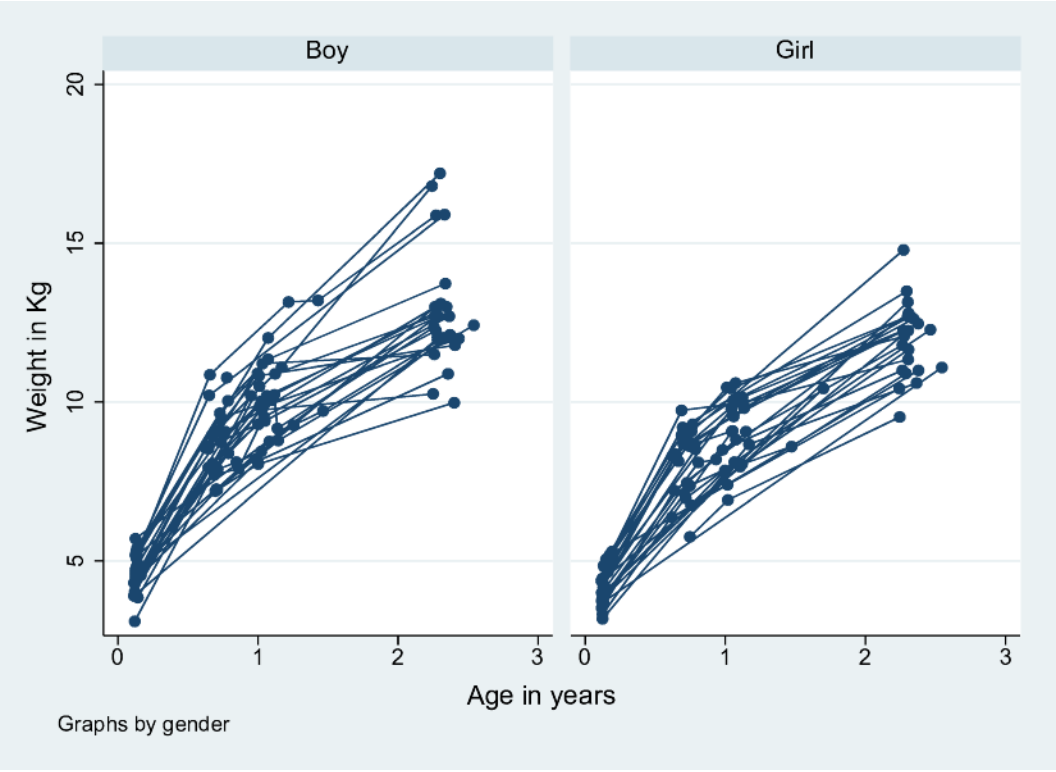



- ```
  generate prediction = ///
      _b[cons]*cons + _b[age]*age + _b[age2]*age2 ///
      + u0 + u1*age
  ```

- ```
  line prediction age, connect(a) ///
      ytitle("Predicted weight in Kg")
  ```




- `label define genderlabel 1 "Boy" 2 "Girl"`
- `label values gender genderlabel`
- ```
  graph twoway (line weight age, connect(ascending)), ///
      by(gender) ///
      xtitle("Age in years") ytitle("Weight in Kg")
  ```
  ```

# Growth curve model by gender

$$weight_{ij} = \beta_0 boy_j + \beta_1 boy_j \times age_{ij} + \beta_2 girl_j + \beta_3 girl_j \times age_{ij} + \beta_4 age_{ij}^2$$

$$+u_{0j} boy_j + u_{1j} boy_j \times age_{ij} + u_{2j} girl_j + u_{3j} girl_j \times age_{ij} + e_{0ij} boy_j + e_{2ij} girl_j$$

$$\begin{pmatrix} u_{0j} \\ u_{1j} \\ u_{2j} \\ u_{3j} \end{pmatrix} \sim \mathrm{N}\left\{ \begin{pmatrix} 0 \\ 0 \\ 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{u0}^2 & & & \\ \sigma_{u01} & \sigma_{u1}^2 & & \\ 0 & 0 & \sigma_{u2}^2 & \\ 0 & 0 & \sigma_{u23} & \sigma_{u3}^2 \end{pmatrix} \right\}$$

$$\begin{pmatrix} e_{0ij} \\ e_{2ij} \end{pmatrix} \sim \mathrm{N}\left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{e0}^2 & \\ 0 & \sigma_{e2}^2 \end{pmatrix} \right\}$$

```
. matrix a = (1,1,1,0,0,1,0,0,1,1)

. runmlwin weight boy boyXage girl girlXage age2, ///
      level2(id: boy boyXage girl girlXage, elements(a)) ///
      level1(occ: boy girl, diagonal) nopause
```

Stata/MP 11.2 - http://www.stata-press.com/data/mlmus2/asian.dta - [Results]

File Edit Data Graphics Statistics User Window Help

| Level Variable | No. of Groups | Observations per Group Minimum | Average | Maximum |
|---|---|---|---|---|
| id | 68 | 1 | 2.9 | 5 |

Run time (seconds) = 1.58
Number of iterations = 7
Log likelihood = -247.49434
Deviance = 494.98868

| weight | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| boy | 3.78267 | .1563113 | 24.20 | 0.000 | 3.476305 | 4.089034 |
| boyXage | 7.728288 | .2567359 | 30.10 | 0.000 | 7.225095 | 8.231481 |
| girl | 3.266411 | .1796806 | 18.18 | 0.000 | 2.914244 | 3.618579 |
| girlXage | 7.502467 | .2341932 | 32.04 | 0.000 | 7.043457 | 7.961477 |
| age2 | -1.624745 | .0849193 | -19.13 | 0.000 | -1.791184 | -1.458306 |

| Random-effects Parameters | Estimate | Std. Err. | [95% Conf. | Interval] |
|---|---|---|---|---|
| **Level 2:** | | | | |
| var(boy) | .1553577 | .1659469 | -.1698922 | .4806076 |
| cov(boy,boyXage) | .102065 | .1232655 | -.1395309 | .3436609 |
| var(boyXage) | .3869624 | .1692804 | .055179 | .7187458 |
| var(girl) | .5685636 | .2111509 | .1547155 | .9824117 |
| cov(girl,girlXage) | .0161196 | .0864426 | -.1533048 | .185544 |
| var(girlXage) | .0799457 | .0608557 | -.0393292 | .1992206 |
| **Level 1:** | | | | |
| var(boy) | .4182827 | .0929099 | .2361826 | .6003828 |
| var(girl) | .2429176 | .0555108 | .1341183 | .3517168 |

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# 3. MULTILEVEL MODELS FOR BINARY RESPONSES

# Guatemalan immunization campaign

- Child immunization data
- 2159 children within 1595 mothers within 161 communities
- First analysed by Pebley, Goldman and Rodriguez (1996) and Rodriguez and Goldman (2001)
- Reanalysed by Rabe-Hesketh and Skrondal (2008) and others

# Three-level binary response model

$$immun_{ijk} \sim \text{Binomial}(1, \pi_{ijk})$$

$$logit(\pi_{ijk}) = \beta_0 + \beta_1 kid2p_{ijk} + \beta_2 rural_k + \beta_3 pcInd81_k + v_k + u_{jk}$$

$$v_k \sim \text{N}(0, \sigma_u^2)$$

$$u_{jk} \sim \text{N}(0, \sigma_u^2)$$

```
. runmlwin immun cons kid2p rural pcInd81, ///
      level3(cluster: cons) ///
      level2(mom: cons) ///
      level1(kid:) ///
      discrete(dist(binomial) link(logit) denom(cons)) ///
      nopause
```

Stata/MP 11.2 - http://www.stata-press.com/data/mlmus2/guatemala.dta - [Results]

File Edit Data Graphics Statistics User Window Help

MLwiN 2.23 multilevel model  Number of obs = 2159
Binomial logit response model
Estimation algorithm: **IGLS, MQL1**

| Level Variable | No. of Groups | Observations per Group Minimum | Average | Maximum |
|---|---|---|---|---|
| **cluster** | 161 | 1 | 13.4 | 55 |
| **mom** | 1595 | 1 | 1.4 | 3 |

Run time (seconds) = 2.89
Number of iterations = 5

| immun | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| cons | -.1433676 | .1721252 | -0.83 | 0.405 | -.4807268 | .1939915 |
| kid2p | .9173057 | .1179051 | 7.78 | 0.000 | .6862159 | 1.148395 |
| rural | -.5668908 | .1480174 | -3.83 | 0.000 | -.8569995 | -.276782 |
| pcInd81 | -.8460267 | .1797028 | -4.71 | 0.000 | -1.198238 | -.4938157 |

| Random-effects Parameters | | Estimate | Std. Err. | [95% Conf. | Interval] |
|---|---|---|---|---|---|
| **Level 3:** | var(cons) | .2960818 | .0772351 | .1447038 | .4474597 |
| **Level 2:** | var(cons) | .3674519 | .1286113 | .1153784 | .6195254 |

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# Refit the model using PQL2

$$immunized_{ijk} \sim \text{Binomial}(1, \pi_{ijk})$$

$$logit(\pi_{ijk}) = \beta_0 + \beta_1 kid2p_{ijk} + \beta_2 rural_k + \beta_3 pcInd81_k + v_k + u_{jk}$$

$$v_k \sim \text{N}(0, \sigma_u^2)$$

$$u_{jk} \sim \text{N}(0, \sigma_u^2)$$

```
. runmlwin immun cons kid2p rural pcInd81, ///
      level3(cluster: cons) ///
      level2(mom: cons) ///
      level1(kid:) ///
      discrete(d(binomial) l(logit) de(cons) pql2) ///
      initsprevious maxiterations(40) nopause
```

Stata/MP 11.2 - http://www.stata-press.com/data/mlmus2/guatemala.dta - [Results]

File Edit Data Graphics Statistics User Window Help

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

MLwiN 2.23 multilevel model  Number of obs = 2159
Binomial logit response model
Estimation algorithm: **IGLS, PQL2**

| Level Variable | No. of Groups | Observations per Group Minimum | Average | Maximum |
|---|---|---|---|---|
| **cluster** | 161 | 1 | 13.4 | 55 |
| **mom** | 1595 | 1 | 1.4 | 3 |

Run time (seconds) = 8.71
Number of iterations = 29

| immun | Coef. | Std. Err. | z | P>\|z\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| cons | -.1897211 | .2437707 | -0.78 | 0.436 | -.6675029 | .2880607 |
| kid2p | 1.363391 | .1542231 | 8.84 | 0.000 | 1.061119 | 1.665663 |
| rural | -.8506848 | .2157692 | -3.94 | 0.000 | -1.273585 | -.427785 |
| pcInd81 | -1.313231 | .2638969 | -4.98 | 0.000 | -1.83046 | -.7960028 |

| Random-effects Parameters | | Estimate | Std. Err. | [95% Conf. | Interval] |
|---|---|---|---|---|---|
| **Level 3:** | var(cons) | .6723186 | .1658299 | .3472979 | .9973393 |
| **Level 2:** | var(cons) | 2.352684 | .2589447 | 1.845162 | 2.860206 |

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# 4. SIMULATION STUDIES ARE EASY

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

File Edit Tools View

rodriguez and goldman (1995).do

```
set seed 12345
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 = 1/10 {
    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: 1, Col: 0 CAP NUM OVR

# 5. MCMC ESTIMATION

# Refit the model using MCMC

$$immun_{ijk} \sim \text{Binomial}(1, \pi_{ijk})$$

$$logit(\pi_{ijk}) = \beta_0 + \beta_1 kid2p_{ijk} + \beta_2 rural_k + \beta_3 pcInd81_k + v_k + u_{jk}$$

$$v_k \sim \text{N}(0, \sigma_u^2)$$

$$u_{jk} \sim \text{N}(0, \sigma_u^2)$$

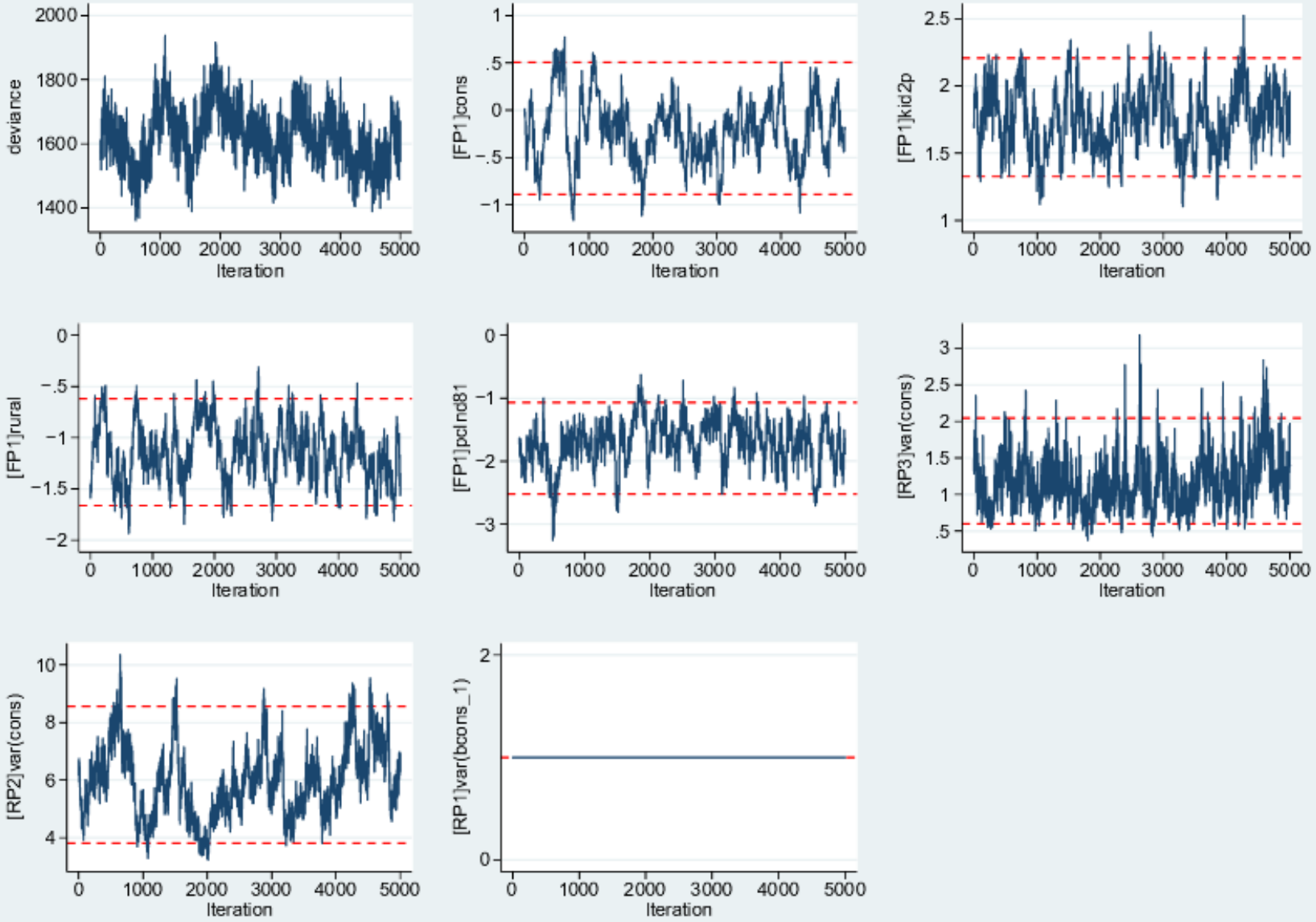
```
. runmlwin immun cons kid2p rural pcInd81, ///
      level3(cluster: cons) ///
      level2(mom: cons) ///
      level1(kid:) ///
      discrete(d(binomial) l(logit) de(cons) pql2) ///
      mcmc(on) initsprevious nopause
```

| Level Variable | No. of Groups | Observations per Group Minimum | Average | Maximum |
|---|---|---|---|---|
| **cluster** | **161** | **1** | **13.4** | **55** |
| **mom** | **1595** | **1** | **1.4** | **3** |

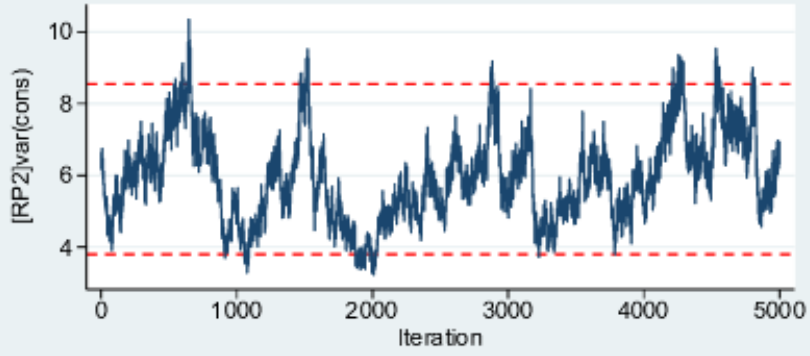
| | | |
|---|---|---|
| Burnin | = | 500 |
| Chain | = | 5000 |
| Run time (seconds) | = | 30 |
| Deviance (dbar) | = | 1619.22 |
| Deviance (thetabar) | = | 866.88 |
| Effective no. of pars (pd) | = | 752.34 |
| Bayesian DIC | = | 2371.56 |

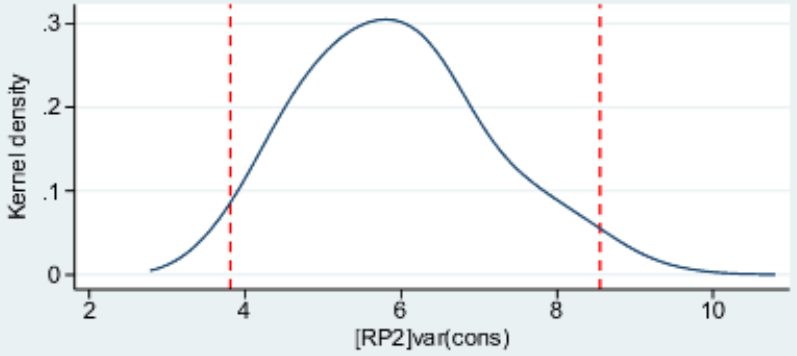
| immun | Mean | Std. Dev. | z | ESS | [95% Cred. | Interval] |
|---|---|---|---|---|---|---|
| cons | -.2200957 | .3358961 | -0.66 | 42 | -.889235 | .5050995 |
| kid2p | 1.754326 | .2300542 | 7.63 | 53 | 1.3257 | 2.208608 |
| rural | -1.145384 | .2759653 | -4.15 | 56 | -1.6628 | -.6193233 |
| pcInd81 | -1.709476 | .3672927 | -4.65 | 61 | -2.520294 | -1.065675 |

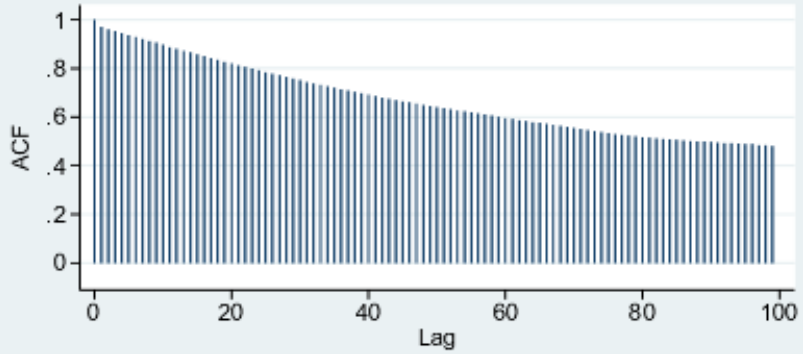
| Random-effects Parameters | | Mean | Std. Dev. | ESS | [95% Cred. | Int] |
|---|---|---|---|---|---|---|
| **Level 3:** | var(cons) | **1.161717** | **.3641234** | **81** | **.6004681** | **2.046271** |
| **Level 2:** | var(cons) | **5.934905** | **1.221375** | **21** | **3.805253** | **8.552722** |

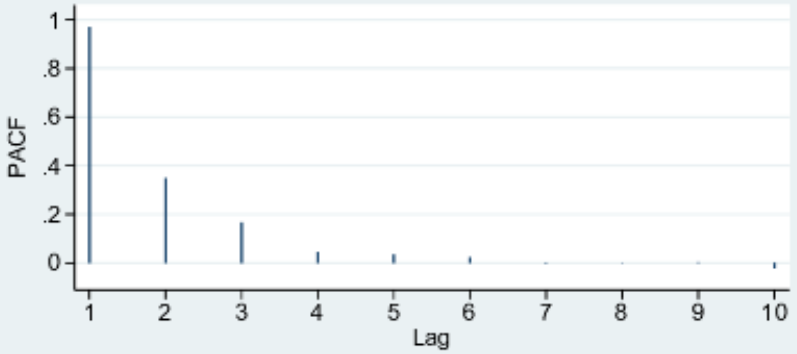


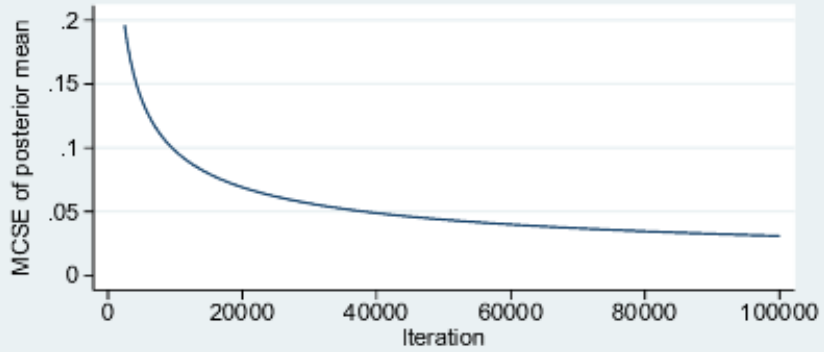

```
. mcmcsum, trajectories
```




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

Stata/MP 11.2 - http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta - [Results]

File Edit Data Graphics Statistics User Window Help

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

                        [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
                                                Brooks Draper (mean)     446390
                                50%   .0765091
                                75%   .1100566
                                95%    .179421
                              97.5%   .2023509
                              99.5%   .2549108
------------------------------------------------------------------------------

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# Run the model for longer

$$immunized_{ijk} \sim \text{Binomial}(1, \pi_{ijk})$$

$$logit(\pi_{ijk}) = \beta_0 + \beta_1 kid2p_{ijk} + \beta_2 rural_k + \beta_3 pcInd81_k + v_k + u_{jk}$$

$$v_k \sim \text{N}(0, \sigma_u^2)$$

$$u_{jk} \sim \text{N}(0, \sigma_u^2)$$

```
. runmlwin immunized cons kid2p rural pcInd81, ///
      level3(cluster: cons) ///
      level2(mom: cons) ///
      level1(kid:) ///
      discrete(d(binomial) l(logit) de(cons) pql2) ///
      mcmc(burnin(5000) chain(50000) thinning(10)) ///
      initsprevious nopause
```

Stata/MP 11.2 - http://www.stata-press.com/data/mlmus2/guatemala.dta - [Results]

File Edit Data Graphics Statistics User Window Help

| Level Variable | No. of Groups | Observations per Group Minimum | Average | Maximum |
|---|---|---|---|---|
| **cluster** | **161** | **1** | **13.4** | **55** |
| **mom** | **1595** | **1** | **1.4** | **3** |

| | | |
|---|---|---|
| Burnin | = | 5000 |
| Chain | = | 50000 |
| Run time (seconds) | = | 257 |
| Deviance (dbar) | = | 1641.35 |
| Deviance (thetabar) | = | 895.18 |
| Effective no. of pars (pd) | = | 746.17 |
| Bayesian DIC | = | 2387.51 |

| immun | Mean | Std. Dev. | z | ESS | [95% Cred. | Interval] |
|---|---|---|---|---|---|---|
| cons | -.2421288 | .3079326 | -0.79 | 424 | -.8276453 | .3486197 |
| kid2p | 1.730911 | .2184296 | 7.92 | 434 | 1.335295 | 2.19006 |
| rural | -1.089141 | .2954561 | -3.69 | 471 | -1.687306 | -.5090104 |
| pcInd81 | -1.681882 | .369106 | -4.56 | 587 | -2.450633 | -.9707532 |

| Random-effects Parameters | | Mean | Std. Dev. | ESS | [95% Cred. | Int] |
|---|---|---|---|---|---|---|
| **Level 3:** | var(cons) | 1.127521 | .3580364 | 572 | .5575184 | 1.94313 |
| **Level 2:** | var(cons) | 5.628252 | 1.25813 | 186 | 3.587712 | 8.415654 |

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# 6. CROSS-CLASSIFIED MODELS

# Scottish neighbourhood study on child educational attainment

- Scottish neighbourhood study on child educational attainment
- 2310 students nested within 17 schools  and 524 neighbourhoods
- First analysed by Garner and Raudenbush (1991)
- Re-analysed by Rabe-Hesketh and Skrondal (2008), Raudenbush (1993), Raudenbush and Bryk (2002) and others

Stata/MP 11.2 - http://www.stata-press.com/data/mlmus2/neighborhood.dta - [Results]

File Edit Data Graphics Statistics User Window Help

Review

| | Command | _rc |
|---|---|---|
| 1 | use "http://www.stata-press.co... | |

Variables

| Name | Label | Type | Format |
|---|---|---|---|
| neighid | | int | %8.0g |
| schid | | byte | %8.0g |
| attain | | float | %9.0g |
| p7vrq | | float | %9.0g |
| p7read | | float | %9.0g |
| dadocc | | float | %9.0g |
| dadunemp | | byte | %8.0g |
| daded | | byte | %8.0g |
| momed | | byte | %8.0g |
| male | | byte | %8.0g |
| deprive | | float | %9.0g |
| dummy | | byte | %8.0g |

```
                                                (R)
  ___  ____  ____  ____  ____
 /__    /   ____/   /   ____/      11.2
___/   /   /___/   /   /___/
  Statistics/Data Analysis

      MP - Parallel Edition

Copyright 2009 StataCorp LP
StataCorp
4905 Lakeway Drive
College Station, Texas 77845 USA
800-STATA-PC        http://www.stata.com
979-696-4600        stata@stata.com
979-696-4601 (fax)

2-user 2-core Stata network perpetual license:
       Serial number:  50110514919
         Licensed to:  Centre for Multilevel Modelling
                       University of Bristol

Notes:
      1.  (/m# option or -set memory-) 500.00 MB allocated to data
      2.  (/v# option or -set maxvar-) 5000 maximum variables

running C:\Program Files (x86)\Stata11\sysprofile.do ...

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

. use "http://www.stata-press.com/data/mlmus2/neighborhood.dta", clear

.
```

Command

C:\Users\gl9158\Documents

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Stata/MP 11.2 - http://www.stata-press.com/data/mlmus2/neighborhood.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
. table neighid schid if inrange(neighid,26,38) | inrange(neighid,251,263) | inrange(neighid
> ,793,800)
```

| neighid | schid 2 | 8 | 10 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|
| 26 | | | | | | | | | 5 |
| 27 | | | | | | | | | 1 |
| 29 | | | | | | | 1 | | 8 |
| 30 | | | | | | | | | 2 |
| 31 | | | | | | | 1 | | 1 |
| 32 | | | | | | | 1 | | 5 |
| 33 | | | | | | | 2 | | 2 |
| 35 | | | | | | | | | 3 |
| 36 | | | | | | | | | 2 |
| 37 | | | | | | | | | 1 |
| 38 | | | | | | | 1 | | 4 |
| 251 | | | | | | 4 | | 1 | |
| 252 | | | | | 1 | 3 | | | 1 |
| 253 | | | | | | 3 | | | |
| 256 | | | | | | | | | 2 |
| 258 | | | | 5 | | | | | |
| 259 | | | | 6 | 1 | | 2 | | |
| 260 | | | | 7 | | | | | |
| 261 | | | | 4 | | | 3 | | |
| 262 | | | | 5 | | 1 | 1 | | |
| 263 | | | | 14 | | 1 | 1 | | |
| 793 | | 1 | 7 | | | | | | |
| 794 | 1 | 1 | 12 | | | | | | |
| 795 | 1 | | 1 | | | | | | |
| 796 | 9 | | | | | | | | |
| 797 | 4 | 1 | | | | | | | |
| 798 | 9 | 1 | | | | | | | |
| 799 | 1 | | 1 | | | | | | |

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CAP NUM OVR

# Two-way cross-classified model

$$attain_i = \beta_0 + u^{(3)}_{\text{schid}(i)} + u^{(2)}_{\text{neighid}(i)} + e_i$$

$$u_j^{(3)} \sim \text{N}\left(0, \sigma^2_{u(3)}\right), \qquad u_j^{(2)} \sim \text{N}\left(0, \sigma^2_{u(2)}\right), \qquad e_i \sim \text{N}(0, \sigma_e^2)$$

```
. matrix b = (0,.33,.33,.33)
. runmlwin attain cons, ///
      level3(schid: cons) ///
      level2(neighid: cons) ///
      level1(studentid: cons) ///
      mcmc(cc) initsb(b)
```

Stata/MP 11.2 - http://www.stata-press.com/data/mlmus2/neighborhood.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
. matrix b = (0,.33,.33,.33)

. runmlwin attain cons, level3(schid: cons) level2(neighid: cons) level1(student
> id: cons) mcmc(cc) initsb(b) nopause

MLwiN 2.23 multilevel model                     Number of obs      =      2310
Normal response model
Estimation algorithm: MCMC
```

| Level Variable | No. of Groups | Observations per Group Minimum | Average | Maximum |
|---|---|---|---|---|
| **schid** | **17** | **22** | **135.9** | **286** |
| **neighid** | **524** | **1** | **4.4** | **16** |

```
Burnin                          =       500
Chain                           =      5000
Run time (seconds)              =      6.88
Deviance (dbar)                 =   6039.42
Deviance (thetabar)             =   5818.77
Effective no. of pars (pd)      =    220.65
Bayesian DIC                    =   6260.07
```

| attain | Mean | Std. Dev. | z | ESS | [95% Cred. | Interval] |
|---|---|---|---|---|---|---|
| cons | .0962458 | .0651659 | 1.48 | 228 | -.0349854 | .2170355 |

| Random-effects Parameters | | Mean | Std. Dev. | ESS | [95% Cred. | Int] |
|---|---|---|---|---|---|---|
| **Level 3:** | var(cons) | .0995634 | .0492998 | 2175 | .0387661 | .2261923 |
| **Level 2:** | var(cons) | .1422148 | .0217524 | 458 | .1033897 | .1892418 |
| **Level 1:** | var(cons) | .8002955 | .0260423 | 2583 | .7513126 | .8540478 |

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# Two-way cross-classified model

$$attain_i = \beta_0 + \beta_1 p7vrq_i + \beta_2 p7read_i + \beta_3 dadocc_i + \beta_4 daded_i$$

$$+\beta_5 momed_i + \beta_6 dadunemp_i + \beta_7 male_i + \beta_8 deprive_i$$

$$+u^{(3)}_{\text{schid}(i)} + u^{(2)}_{\text{neighid}(i)} + e_i$$

$$u_j^{(3)} \sim \text{N}\left(0, \sigma^2_{u(3)}\right), \qquad u_j^{(2)} \sim \text{N}\left(0, \sigma^2_{u(2)}\right), \qquad e_i \sim \text{N}(0, \sigma_e^2)$$

```
. matrix b = (0,0,0,0,0,0,0,0,0,1,1,1)
. runmlwin attain cons p7vrq p7read dadocc daded ///
      momed dadunemp male deprive, ///
      level3(schid: cons) ///
      level2(neighid: cons) ///
      level1(studentid: cons) mcmc(cc) initsb(b)
```

Stata/MP 11.2 - http://www.stata-press.com/data/mlmus2/neighborhood.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
.
. runmlwin attain cons p7vrq p7read ///
>         dadocc daded momed dadunemp female deprive, ///
>         level3(schid: cons) ///
>         level2(neighid: cons) ///
>         level1(studentid: cons) ///
>         mcmc(cc) initsb(b) ///
>         nopause

MLwiN 2.23 multilevel model                       Number of obs      =      2310
Normal response model
Estimation algorithm: MCMC
```

| Level Variable | No. of Groups | Observations per Group Minimum | Average | Maximum |
|---|---|---|---|---|
| schid | 17 | 22 | 135.9 | 286 |
| neighid | 524 | 1 | 4.4 | 16 |

```
Burnin                         =       500
Chain                          =      5000
Run time (seconds)             =      26.6
Deviance (dbar)                =   4744.77
Deviance (thetabar)            =   4704.11
Effective no. of pars (pd)     =     40.67
Bayesian DIC                   =   4785.44
```

| attain | Mean | Std. Dev. | z | ESS | [95% Cred. | Interval] |
|---|---|---|---|---|---|---|
| cons | .0351255 | .0291963 | 1.20 | 1706 | -.0220368 | .0938575 |
| p7vrq | .0275779 | .0022758 | 12.12 | 4556 | .0231709 | .03204 |
| p7read | .0262253 | .0017897 | 14.65 | 4689 | .0226729 | .0297626 |
| dadocc | .0080741 | .0013761 | 5.87 | 4680 | .0053839 | .0107416 |
| daded | .142757 | .0411453 | 3.47 | 5452 | .0615814 | .2230719 |
| momed | .0605109 | .0379741 | 1.59 | 4703 | -.0132536 | .1342922 |
| dadunemp | -.1224487 | .0468065 | -2.62 | 4505 | -.2130983 | -.028468 |
| female | .0558048 | .0280615 | 1.99 | 4699 | .0015048 | .1117451 |
| deprive | -.1562503 | .0260965 | -5.99 | 3705 | -.207776 | -.1055711 |

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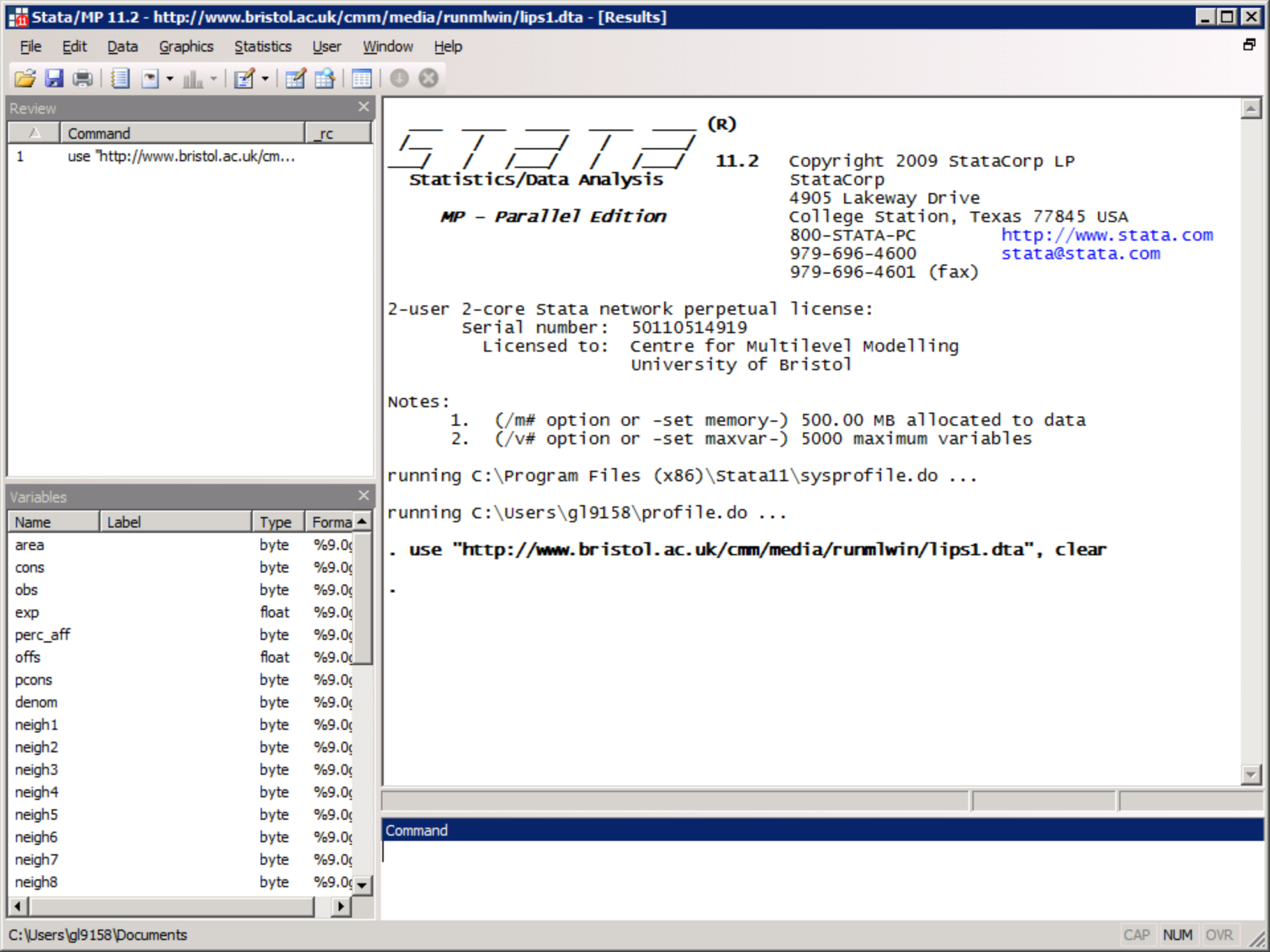
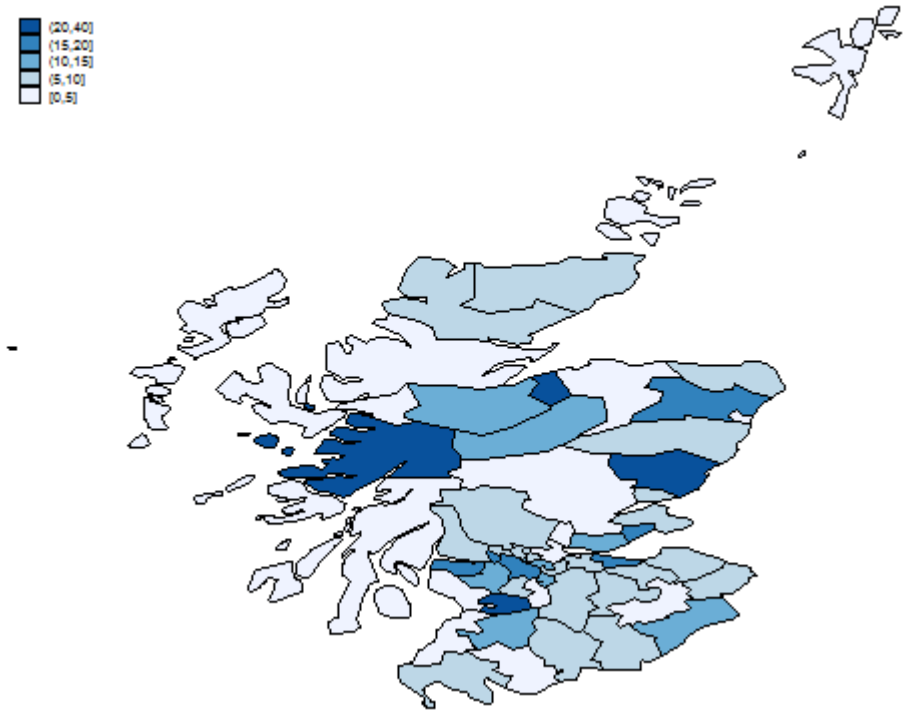
CAP NUM OVR

# 7. SPATIAL MULTILEVEL MODELS

# Scottish lip cancer

- County level lip cancer counts between 1975 and 1980
- 56 Scottish counties
- First analysed by Clayton and Kaldor (1987)
- Re-analysed by Breslow and Clayton (1993), Leyland and Goldstein (2001), Rabe-Hesketh and Skrondal (2008) and others


Stata/MP 11.2 - http://www.bristol.ac.uk/cmm/media/runmlwin/lips1.dta - [Results]
File Edit Data Graphics Statistics User Window Help
Review
Command _rc
1 use "http://www.bristol.ac.uk/cm...
Variables
Name Label Type Forma
area byte %9.0
cons byte %9.0
obs byte %9.0
exp float %9.0
perc_aff byte %9.0
offs float %9.0
pcons byte %9.0
denom byte %9.0
neigh1 byte %9.0
neigh2 byte %9.0
neigh3 byte %9.0
neigh4 byte %9.0
neigh5 byte %9.0
neigh6 byte %9.0
neigh7 byte %9.0
neigh8 byte %9.0
(R)
11.2
Statistics/Data Analysis
MP - Parallel Edition
Copyright 2009 StataCorp LP
StataCorp
4905 Lakeway Drive
College Station, Texas 77845 USA
800-STATA-PC http://www.stata.com
979-696-4600 stata@stata.com
979-696-4601 (fax)
2-user 2-core Stata network perpetual license:
Serial number: 50110514919
Licensed to: Centre for Multilevel Modelling
University of Bristol
Notes:
1. (/m# option or -set memory-) 500.00 MB allocated to data
2. (/v# option or -set maxvar-) 5000 maximum variables
running C:\Program Files (x86)\Stata11\sysprofile.do ...
running C:\Users\gl9158\profile.do ...
. use "http://www.bristol.ac.uk/cmm/media/runmlwin/lips1.dta", clear
.
Command
C:\Users\gl9158\Documents
CAP NUM OVR




- use "http://www.bristol.ac.uk/cmm/media/runmlwin/lips1.dta", clear

- merge 1:1 area using "scotdb.dta"

- spmap obs using "scotcoord.dta", id(area) ///
  fcolor(Blues) legend(position(10)) ///
  clmethod(custom) clbreaks(0 5 10 15 20 40)

# Over-dispersed Poisson model

$$obs_i \sim \text{Poisson}(\pi_i)$$

$$log(\pi_i) = offs_i + \beta_0 + \beta_1 perc\_aff_i + u_i$$

$$u_i \sim \text{N}(0, \sigma_u^2)$$

```
runmlwin obs cons perc_aff, ///
        level2(area: cons) ///
        level1(area:) ///
        discrete(dist(poisson) link(log) offset(offs)) ///
        mcmc(chain(50000)) ///
        initsprevious nopause
```

Stata/MP 11.2 - http://www.bristol.ac.uk/cmm/media/runmlwin/lips1.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
. runmlwin obs cons perc_aff, level2(area:cons) level1(area:) discrete(distribut
> ion(poisson) link(log) offset(offs)) mcmc(chain(50000) refresh(500)) initsprev
> ious nopause

MLwiN 2.23 multilevel model                       Number of obs      =        56
Poisson response model
Estimation algorithm: MCMC, MQL1
```

| Level Variable | No. of Groups | Observations per Group Minimum | Average | Maximum |
|---|---|---|---|---|
| **area** | **56** | **1** | **1.0** | **1** |

| | |
|---|---|
| Burnin | = 500 |
| Chain | = 50000 |
| Run time (seconds) | = 10.3 |
| Deviance (dbar) | = 270.38 |
| Deviance (thetabar) | = 230.65 |
| Effective no. of pars (pd) | = 39.73 |
| Bayesian DIC | = 310.11 |

| obs | Mean | Std. Dev. | z | ESS | [95% Cred. | Interval] |
|---|---|---|---|---|---|---|
| cons | -.4835851 | .1628447 | -2.97 | 494 | -.8143693 | -.1711187 |
| perc_aff | .0675449 | .0143747 | 4.70 | 475 | .0388835 | .0956604 |

| Random-effects Parameters | | Mean | Std. Dev. | ESS | [95% Cred. | Int] |
|---|---|---|---|---|---|---|
| **Level 2:** | var(cons) | .3852672 | .1125743 | 6787 | .2107703 | .645173 |

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CAP NUM OVR

# CAR model

$$obs_i \sim \text{Poisson}(\pi_i)$$

$$\log(\pi_i) = offs_i + \beta_0 + \beta_1 perc\_aff_i + u_i$$

$$u_i \sim \text{N}\left(\bar{u}_i, \frac{\sigma_u^2}{r_i}\right), \qquad \bar{u}_i = \sum_{j \in neigh(i)} \frac{w_{i,j} u_i}{r_i}$$

```
. runmlwin obs perc_aff, ///
      level2(area: cons, carids(neigh1-neigh11) ///
      carweights(wcar1-wcar11)) ///
      level1(cons:) ///
      discrete(dist(poisson) link(log) offset(offs)) ///
      mcmc(chain(50000)) initsp nopause
```

Stata/MP 11.2 - http://www.bristol.ac.uk/cmm/media/runmlwin/lips1.dta - [Results]

File Edit Data Graphics Statistics User Window Help

```
. runmlwin obs perc_aff, level2(area: cons, carids(neigh1-neigh11) carweights(wcar1-wcar11))
>  level1(cons:) discrete(distribution(poisson) link(log) offset(offs)) mcmc(chain(50000) re
> fresh(500)) initsprevious nopause

MLwiN 2.23 multilevel model                       Number of obs      =        56
Poisson response model
Estimation algorithm: MCMC, MQL1
```

| Level Variable | No. of Groups | Observations per Group Minimum | Average | Maximum |
|---|---|---|---|---|
| **area** | **56** | **1** | **1.0** | **1** |

| | | |
|---|---|---|
| Burnin | = | **500** |
| Chain | = | **50000** |
| Run time (seconds) | = | **9.67** |
| Deviance (dbar) | = | **268.77** |
| Deviance (thetabar) | = | **240.42** |
| Effective no. of pars (pd) | = | **28.35** |
| Bayesian DIC | = | **297.13** |

| obs | Mean | Std. Dev. | z | ESS | [95% Cred. Interval] | |
|---|---|---|---|---|---|---|
| perc_aff | **.035667** | **.0128288** | **2.78** | **354** | **.0090298** | **.0591634** |

| Random-effects Parameters | | Mean | Std. Dev. | ESS | [95% Cred. Int] | |
|---|---|---|---|---|---|---|
| **Level 2:** | var(cons) | **.5337886** | **.1900985** | **3602** | **.2512767** | **.9866003** |

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CAP NUM OVR

# Convolution model

$$obs_i \sim \text{Poisson}(\pi_i)$$

$$\log(\pi_i) = offs_i + \beta_0 + \beta_1 perc_{aff_i} + v_i + u_i$$

$$v_i \sim \text{N}\left(\bar{v}_i, \frac{\sigma_v^2}{r_i}\right), \qquad \bar{v}_i = \sum_{j \in neigh(i)} \frac{w_{i,j} v_i}{r_i}$$

$$u_i \sim \text{N}(0, \sigma_u^2)$$

```
. runmlwin observed cons perc_aff, ///
      level3(area: cons, carids(neigh1-neigh11) ///
      carweights(wcar1-wcar11)) ///
      level2(area: cons) level1(county:) ///
      discrete(d(binomial) l(log) offset(offs)) ////
      mcmc(on) initsprevius nopause
```

Stata/MP 11.2 - http://www.bristol.ac.uk/cmm/media/runmlwin/lips1.dta - [Results]

File Edit Data Graphics Statistics User Window Help

MLwiN 2.23 multilevel model  Number of obs = 56
Poisson response model
Estimation algorithm: **MCMC**, **MQL1**

| Level Variable | No. of Groups | Observations per Group Minimum | Average | Maximum |
|---|---|---|---|---|
| **area** | 56 | 1 | 1.0 | 1 |

| | | |
|---|---|---|
| Burnin | = | 500 |
| Chain | = | 50000 |
| Run time (seconds) | = | 14.6 |
| Deviance (dbar) | = | 267.86 |
| Deviance (thetabar) | = | 238.12 |
| Effective no. of pars (pd) | = | 29.74 |
| Bayesian DIC | = | 297.60 |

| obs | Mean | Std. Dev. | z | ESS | [95% Cred. | Interval] |
|---|---|---|---|---|---|---|
| cons | .8812095 | 1.762997 | 0.50 | 26 | -2.068313 | 3.722563 |
| perc_aff | .0365398 | .0136445 | 2.68 | 472 | .0084325 | .0622706 |

| Random-effects Parameters | | Mean | Std. Dev. | ESS | [95% Cred. | Int] |
|---|---|---|---|---|---|---|
| **Level 3:** | var(cons) | .4903258 | .1894587 | 2166 | .2036356 | .9411708 |
| **Level 2:** | var(cons) | .0236907 | .0324559 | 208 | .0006044 | .1154397 |

C:\Users\gl9158\Documents  CAP NUM OVR

# 8. EXPORT MODELS TO WINBUGS

# The `runmlwin` command syntax

$$normexam_{ij} = \beta_0 + \beta_1 standlrt_{ij} + u_j + e_{ij}$$

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

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

```
. runmlwin normexam cons standlrt, ///
      level2(school: cons) ///
      level1(student: cons) ///
      mcmc(savewinbugs(model(m.txt) inits(i.txt) ///
      data(d.txt) nofit)) ///
      initsprevious nopause
```

Viewer (#1) [view m.txt]

view m.txt

Advice | Contents | What's New | News

```
# WINBUGS 1.4 code generated from MLwiN program

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

model
{
# Level 1 definition
for(i in 1:N) {
normexam[i] ~ dnorm(mu[i],tau)
mu[i]<- beta[1] * cons[i]
+ beta[2] * standlrt[i]
+ u2[school[i]] * cons[i]
}
# Higher level definitions
for (j in 1:n2) {
u2[j] ~ dnorm(0,tau.u2)
}
# Priors for fixed effects
for (k in 1:2) { beta[k] ~ dflat() }
# Priors for random terms
tau ~ dgamma(0.001000,0.001000)
sigma2 <- 1/tau
tau.u2 ~ dgamma(0.001000,0.001000)
sigma2.u2 <- 1/tau.u2
}
```

# $t$-distributed level 2 residuals

$$normexam_{ij} = \beta_0 + \beta_1 standlrt_{ij} + u_j + e_{ij}$$

$$u_j \sim t(0, \sigma_u^2, \nu)$$

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

Viewer (#1) [view m.txt]

view m.txt

Advice | Contents | What's New | News

```
# WINBUGS 1.4 code generated from MLwiN program

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

model
{
# Level 1 definition
for(i in 1:N) {
normexam[i] ~ dnorm(mu[i],tau)
mu[i]<- beta[1] * cons[i]
+ beta[2] * standlrt[i]
+ u2[school[i]] * cons[i]
}
# Higher level definitions
for (j in 1:n2) {
u2[j] ~ dt(0,tau.u2,df)
}
# Priors for fixed effects
for (k in 1:2) { beta[k] ~ dflat() }
# Priors for random terms
tau ~ dgamma(0.001000,0.001000)
sigma2 <- 1/tau
tau.u2 ~ dgamma(0.001000,0.001000)
sigma2.u2 <- 1/tau.u2
df ~ dunif(2,200)
}
```

# The `winbugs` suite of commands

```
. wbscript , ///
      model("`c(pwd)'\m.txt") inits("`c(pwd)'\i.txt") ///
      data("`c(pwd)'\d.txt") coda("`c(pwd)'\out") ///
      set(df) burn(500) update(5000) ///
      saving("`c(pwd)'\script.txt", replace) quit

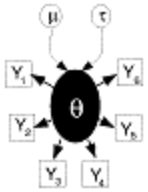
. wbrun, script("`c(pwd)'\script.txt") ///
      winbugs("C:\Users\gl9158\WinBUGS14\winbugs14.exe")

. wbcoda, root("`c(pwd)'\out") clear
```

WinBUGS14

File Tools Edit Attributes Info Model Inference Options Doodle Map Text Window Help

WinBUGS Licence




# Licence Agreement

Introduction

This software and any associated documentation whether electronic or p
(hereinafter called "WinBUGS PACKAGE") is made available under a lic
agreement and may be used only in accordance with the terms of that a
This is a legal agreement between you (the Licensee), and MRC and Imp
College of Science, Technology and Medicine (the Licenser). The terms
provided in the following pages.

Users are required to register and to pay a fee for the use of the
WinBUGS PACKAGE. Details of fees and the procedure for
registration and acceptance of the licence terms is provided here.
There is no fee payable for the use of the demonstration (Internet) versio
WinBUGS package. Users of the demonstration version of the WinBUGS
package can upgrade to the full version on payment of a fee.

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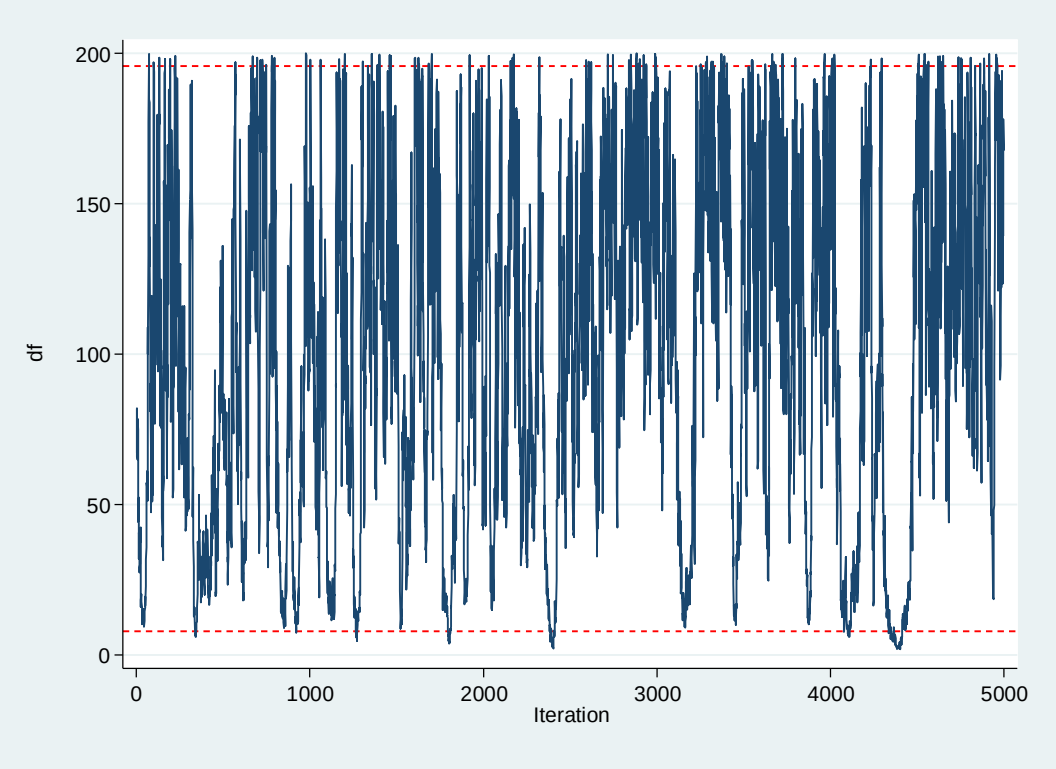
By completing and sending the registration you demonstrate your agreer
the terms of this licence and will become legally bound to the terms ther

It should be emphasised that the statistical tools provided in the
WinBUGS PACKAGE are by their very nature partly subjective. The Lice
offer advice on interpretation of results obtained using the WinBUGS PA
Any assistance will be strictly limited to attempting to help if there

Log

```
display(log)
check(Q:/C-modelling/runmlwin/presentations/2011-05-26
Connecticut/m_modified.txt)
model is syntactically correct
data(Q:/C-modelling/runmlwin/presentations/2011-05-26
Connecticut/d.txt)
data loaded
compile(1)
model compiled
inits(1,Q:/C-modelling/runmlwin/presentations/2011-05-26
Connecticut/i_modified.txt)
model is initialized
gen.inits()
command #Bugs:gen.inits cannot be executed (is greyed out)
update(500)
set(df)
update(5000)
coda(*,Q:/C-modelling/runmlwin/presentations/2011-05-26
Connecticut/out)
```




```
. mcmcsum df, trajectories variables
```

Stata/MP 11.2 - [Results]

File Edit Data Graphics Statistics User Window Help

```
. mcmcsum df, variables

                                    df
------------------------------------------------------------------------------

                                Percentiles
Mean                100.3878      0.5%     3.102855   Thinned Chain Length  5000
MCSE of Mean        4.172605      2.5%     7.934025   Effective Sample Size  107
Std. Dev.           57.77448        5%       11.977   Raftery Lewis (2.5%)  57207
Mode                21.98396       25%      49.3425   Raftery Lewis (97.5%)  5464
                                                      Brooks Draper (mean)  13383
                                   50%       102.25
                                   75%        149.4
                                   95%        191.2
                                 97.5%        195.8
                                 99.5%        199.3
------------------------------------------------------------------------------
```

Q:\C-modelling\runmlwin\presentations\2011-05-26 Connecticut

CAP NUM OVR

# 9. WORK EFFICIENTLY

Do-file Editor - Connecticut.do

File Edit Tools View

Connecticut.do

```
46
47  ********************************************************************************
48  * (1) TWO-LEVEL MULTILEVEL MODELS
49  ********************************************************************************
50
51  use "http://www.bristol.ac.uk/cmm/media/runmlwin/tutorial.dta", clear
52
53  runmlwin normexam cons, ///
54      level2(school: cons) ///
55      level1(student: cons)
56
57  runmlwin normexam cons, ///
58      level2(school: cons, residuals(u)) ///
59      level1(student: cons) nopause
60
61  egen pickone = tag(school)
62
63  preserve
64
65      keep if pickone==1
66
67      egen u0rank = rank(u0)
68
69      serrbar u0 u0se u0rank, scale(1.96) yline(0)
70
71      summarize u0
72
73      generate u0std = (u0 - r(mean))/r(sd)
74
75      generate u0uniform = (u0rank - 0.5)/_N
76
77      generate u0nscore = invnorm(u0uniform)
78
79      scatter u0std u0nscore, ///
80          yline(0) xline(0) ylabel(-3(1)3) xlabel(-3(1)3) ///
81          aspectratio(1)
```

Ready

Line: 26, Col: 1 CAP NUM OVR

# 10. RESOURCES TO HELP YOU LEARN RUNMLWIN

# help runmlwin

## Title

**runmlwin** - Run the MLwiN multilevel modelling software from within Stata

## Syntax

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

where the syntax of *responses_and_fixed_part* is one of the following

for univariate continuous, binary, proportion and count response models

*depvar indepvars* [*if*] [*in*]

for univariate ordered and unordered categorical response models

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

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

for multivariate response models

(*depvar1 indepvars1*, **equation(***numlist***)**)
(*depvar2 indepvars2*, **equation(***numlist***)**)
[(*depvar3 indepvars3*, **equation(***numlist***)**)]
[ ... ]
[*if*] [*in*]

where **equation(***numlist***)** specifies equation numbers. Equation numbers are indexed 1,2,... up to the total number of equations (i.e. response variables) included in the model.

and the syntax of *random_part* is

[ ... ] [level2(*levelvar*: [*varlist*] [, *random_part_options*])]
level1(*levelvar*: [*varlist*] [, *random_part_options*])

## 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 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)*
*(You will need to click the "Resume macro" button twice in MLwiN to fit the model.)*

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

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)
```

Refit the model suppressing the two pauses in MLwiN (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)
```

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))
```

Two-level random-intercept and random-slope (coefficient) model using MCMC (where we first fit the model using IGLS to obtain initial values for the MCMC chains)
*(See page 71 of the MLwiN MCMC Manual)*

```
. runmlwin normexam cons standlrt, level2 (school: cons standlrt) level1 (student: cons)
. runmlwin normexam cons standlrt, level2 (school: cons standlrt) level1 (student: cons) mcmc(on)
    initsprevious
```

Multivariate response models

---

SOFTWARE

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

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

# 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 > >

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

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

# Presentations using runmlwin

- 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)
  - Slides (PDF, 1.7mb)
  - Stata do-file (do, 0.1mb) to replicate all analyses presented in the slides.
- 8th International Amsterdam Multilevel Conference (17th March 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)

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- Rasbash, J., Charlton, C., Browne, W.J., Healy, M. and Cameron, B. 2009. MLwiN Version 2.1. Centre for Multilevel Modelling, University of Bristol.

For models fitted using MCMC estimation, we ask that you additionally cite:

- Browne, W.J. 2009. MCMC Estimation in MLwiN, v2.13. Centre for Multilevel Modelling, University of Bristol.

## Papers using runmlwin

Please let George Leckie (g.leckie@bristol.ac.uk) know of any further publications using **runmlwin** including forthcoming papers, books, PhD theses, etc.

- Cheung, C., Goodman, D., Leckie, G. and Jenkins, J. (2011) Understanding Contextual Effects on Externalizing Behaviors in Children in Out-of-home Care: Influence of Workers and Foster Families. *Children and Youth Services Review,* 33, 2050-2060.

- Chung, H. and Beretvas, S.N. (2011) The Impact of ignoring multiple membership data structures in multilevel models. *British Journal of Mathematical and Statistical Psychology. Forthcoming.*

- Leckie, G. and Baird, J.-A. (2011) Rater effects on essay scoring: A multilevel analysis of severity drift, central tendency and rater experience. *Journal of Educational Measurement. Forthcoming.*

- Leckie, G., Pillinger, R., Jones, K. and Goldstein, H. (2011) Multilevel modelling of social segregation. *Journal of Educational and Behavioral Statistics. Forthcoming.*

- Paternoster, L., Howe, L. D., Tilling, K., Weedon, M. N., Freathy, R. M., Frayling, T. M., Kemp, J. P., Davey Smith, G., Timpson, N. J. Ring, S. M., Evans, D. M. and Lawlor, D. A. (2011) Adult height variants affect birth length and growth rate in children. *Human Molecular Genetics. Forthcoming*

## Books discussing runmlwin

- Snijders, T. and Bosker, R. (2011) Multilevel Analysis: An Introduction to Basic and Advanced Multilevel Modeling, Second Edition. *Sage. Forthcoming.*

# runmlwin user forum

Forum rules

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20 topics • Page 1 of 1

| ANNOUNCEMENTS | REPLIES | VIEWS | LAST POST |
|---|---|---|---|
| **Do-files to replicate entire MLwiN User & MCMC Manuals**<br>by GeorgeLeckie » Mon Apr 18, 2011 5:30 pm | 0 | 123 | by GeorgeLeckie<br>Mon Apr 18, 2011 5:30 pm |
| **Welcome to the runmlwin discussion forum**<br>by GeorgeLeckie » Fri Apr 01, 2011 4:06 pm | 0 | 130 | by GeorgeLeckie<br>Fri Apr 01, 2011 4:06 pm |

| TOPICS | REPLIES | VIEWS | LAST POST |
|---|---|---|---|
| **MVs & error message 'line too long'**<br>by julia1633 » Mon Aug 15, 2011 3:17 pm 1 2 | 17 | 125 | by julia1633<br>Sun Aug 28, 2011 12:05 am |
| **runmlwin in Batch mode - gui causing error?**<br>by ash » Sat Aug 27, 2011 6:43 am | 2 | 20 | by ash<br>Sat Aug 27, 2011 9:07 pm |
| **Bug in residuals(u, savechains("u.dta", replace)) ?**<br>by ash » Mon Aug 01, 2011 7:06 pm | 4 | 76 | by GeorgeLeckie<br>Wed Aug 03, 2011 6:25 pm |
| **Predictions via the runmlwin interface: a clarification**<br>by ewancarr » Tue Jul 26, 2011 6:49 pm | 6 | 84 | by GeorgeLeckie<br>Wed Jul 27, 2011 7:04 pm |
| **highly correlated multivariate depenents -> numerical error**<br>by ash » Sat Jul 23, 2011 10:48 am | 1 | 67 | by GeorgeLeckie<br>Mon Jul 25, 2011 3:49 pm |
| **Input dataset contains double precision data...**<br>by ewancarr » Wed Jul 13, 2011 3:55 pm | 2 | 81 | by ewancarr<br>Wed Jul 13, 2011 9:16 pm |
| **Modelling Count Data (example do-file) - mismatch error**<br>by leap » Tue Jul 12, 2011 10:18 am | 1 | 48 | by ChrisCharlton<br>Wed Jul 13, 2011 3:32 pm |
| **Error code: r(-1073740777);**<br>by pd65 » Mon Jul 04, 2011 11:01 am | 7 | 207 | by GeorgeLeckie<br>Thu Jul 07, 2011 3:15 pm |
| **MCMC estimation**<br>by ianna » Fri Apr 08, 2011 9:20 am | 5 | 293 | by ChrisCharlton<br>Thu Jun 09, 2011 10:09 am |

# Citing `runmlwin`

- If you use `runmlwin` in your work, please cite `runmlwin`
- Leckie, G. and Charlton, C. (2011) *runmlwin: Stata module for fitting multilevel models in the MLwiN software package*. Centre for Multilevel Modelling, University of Bristol.
- We can then add you to the list of papers using `runmlwin` on our website
- http://www.bristol.ac.uk/cmm/software/runmlwin/citations