**PSC 8185: Multilevel Modeling**
**Fitting Random Coefficient Binary Response Models in Stata**

Consider the following two-level model random coefficient logit model. This is a Supreme Court decision making model, where level-1 units are justices' votes and level-2 units are court cases (justices' votes (3544) nested within 399 cases). For binary dependent variables, a Bernoulli sampling model is used, and I use a logit link here. For the logit link, first define $\Pr(Y_{ij}=1) = p_{ij}$, which is the probability of a liberal vote for choice $i$ in case $j$. Then define $\eta_{ij}$ as the log-odds of $p_{ij}$: $\eta_{ij} = \log[p_{ij} / (1 - p_{ij})]$. This allows one to specify the log-odds as a linear function of the level-1 independent variables.

[Level-1 eq.] $$\eta_{ij} = \beta_{0j} + \beta_{1j}PREF_{ij}$$

[Level-2 eqs.]
$$\beta_{0j} = \gamma_{00} + \gamma_{01}SAL_j + \gamma_{02}COMP_j + \gamma_{03}ISSUEFAM_j + \gamma_{04}INFO_j + \gamma_{05}USAMICUS_j + \gamma_{06}USPARTY_j + \gamma_{07}STAT_j + u_{0j}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}SAL_j + \gamma_{12}COMP_j + \gamma_{13}ISSUEFAM_j + \gamma_{14}INFO_j + \gamma_{15}USAMICUS_j + \gamma_{16}USPARTY_j + \gamma_{17}STAT_j + u_{1j}$$

*Reduced-form Representation of Model 2*:

$$\eta_{ij} =$$

| | |
|---|---|
| *Effects on case outcome* | $\gamma_{00} + \gamma_{01}SAL_j + \gamma_{02}COMP_j + \gamma_{03}ISSUEFAM_j + \gamma_{04}INFO_j + \gamma_{05}USAMICUS_j + \gamma_{06}USPARTY_j + \gamma_{07}STAT_j +$ |
| *Avg. effect of preferences* | $\gamma_{10}*PREF_{ij} +$ |
| *Cross-level interactions* | $\gamma_{11}SAL_j*PREF_{ij} + \gamma_{12}COMP_j*PREF_{ij} + \gamma_{13}ISSUEFAM_j*PREF_{ij} + \gamma_{14}INFO_j*PREF_{ij} + \gamma_{15}USAMICUS_j*PREF_{ij} + \gamma_{16}USPARTY_j*PREF_{ij} + \gamma_{17}STAT_j*PREF_{ij} +$ |
| *Error components* | $u_{0j} + u_{1j}*PREF_{ij}$ |

## Fitting the Two-Level Model using Full Maximum Likelihood (Adaptive Quadrature) in GLLAMM

```
set more off

*ADAPTIVE QUADRATURE MODELS

*Generate a constant; gllamm needs this
gen cons=1

*Specify random intercept and random coefficient
eq cons: cons
eq pref: lagpctlib_use

*Specify the level-2 variables that are a function of the random intercept
eq f1: salience_nyt_cen complex_3pt_cen lnissuecount_cen infoenv_01_cen
usamicus_cen usparty_cen statutory_cen

*Specify the level-2 variables that are a function of the random coefficient
eq f2: salience_nyt_cen complex_3pt_cen lnissuecount_cen infoenv_01_cen
usamicus_cen usparty_cen statutory_cen

*Model command; start with 4 quadrature points, then 8, then 12, etc.; use
*start values from the previous model (that's the "from(a)" command)
gllamm dir lagpctlib_use, i(caseid) l(logit) f(binom) nrf(2) eqs(cons pref)
geqs(f1 f2) adapt nip(4)

matrix a=e(b)

gllamm dir lagpctlib_use, i(caseid) l(logit) f(binom) nrf(2) eqs(cons pref)
geqs(f1 f2) adapt nip(8) from(a)

matrix a=e(b)

gllamm dir lagpctlib_use, i(caseid) l(logit) f(binom) nrf(2) eqs(cons pref)
geqs(f1 f2) adapt nip(12) from(a)

est store lag_adapt12

matrix a=e(b)

gllamm dir lagpctlib_use, i(caseid) l(logit) f(binom) nrf(2) eqs(cons pref)
geqs(f1 f2) adapt nip(16) from(a)

est store lag_adapt16

matrix a=e(b)

gllamm dir lagpctlib_use, i(caseid) l(logit) f(binom) nrf(2) eqs(cons pref)
geqs(f1 f2) adapt nip(20) from(a)

est store lag_adapt20

*Present results in a table form
est table lag_adapt12 lag_adapt16 lag_adapt20, se p varwidth(34) stats(N ll
aic)
```

## GLLAMM OUTPUT

```
. *ADAPTIVE QUADRATURE MODELS

[Suppressing output from models using 4 and 8 quadrature points.]

. gllamm dir lagpctlib_use if lagpctlib_use~=., i(caseid) l(logit) f(binom)
nrf(2) eqs(cons pref) geqs(f1 f2) adapt nip (12) from(a)

Running adaptive quadrature
Iteration 0:    log likelihood = -1433.9683
Iteration 1:    log likelihood = -1433.9498
Iteration 2:    log likelihood = -1433.9498


Adaptive quadrature has converged, running Newton-Raphson
Iteration 0:   log likelihood = -1433.9498
Iteration 1:   log likelihood = -1433.9498  (backed up)
Iteration 2:   log likelihood = -1433.9496
Iteration 3:   log likelihood = -1433.9496

number of level 1 units = 3544
number of level 2 units = 399

Condition Number = 15.170465

gllamm model

log likelihood = -1433.9496

------------------------------------------------------------------------------
         dir |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lagpctlib_~e |   4.469579   .3126479    14.30   0.000       3.8568    5.082357
       _cons |  -.3927239   .2204633    -1.78   0.075     -.824824    .0393763
------------------------------------------------------------------------------

Variances and covariances of random effects
------------------------------------------------------------------------------

***level 2 (caseid)

    var(1): 15.246868 (2.1409271)
    cov(2,1): .47004543 (1.589734) cor(2,1): .03597937

    var(2): 11.194171 (2.0465321)

Regressions of latent variables on covariates
------------------------------------------------------------------------------

    random effect 1 has 7 covariates:
    salience_nyt_cen: 1.3087985 (.53243653)
    complex_3pt_cen: -.23641807 (.91949432)
    lnissuecount_cen: .0830284 (.21363707)
    infoenv_01_cen: -3.2768549 (2.4414709)
    usamicus_cen: -1.2216683 (.55349651)
    usparty_cen: -1.6855654 (.58330776)
    statutory_cen: .20317709 (.45585559)
```

```
    random effect 2 has 7 covariates:
    salience_nyt_cen: 1.4321357 (.63688317)
    complex_3pt_cen: -.37590127 (1.0727686)
    lnissuecount_cen: .52559336 (.25446341)
    infoenv_01_cen: -.23535991 (2.9681077)
    usamicus_cen: -.7769956 (.6769883)
    usparty_cen: -1.3340209 (.70159345)
    statutory_cen: -.6900348 (.54179413)
------------------------------------------------------------------------------

. est store lag_adapt12

[Suppressing output from models using 16 and 20 quadrature points.]
.
. est table lag_adapt12 lag_adapt16 lag_adapt20, se p varwidth(34) stats(N ll
aic)

------------------------------------------------------------------------------
                         Variable | lag_ada~12   lag_ada~16   lag_ada~20
----------------------------------+-------------------------------------------
dir                               |
                     lagpctlib_use |  4.4695786    4.4671294    4.4646248
                                   |   .3126479    .31198263    .31178696
                                   |     0.0000       0.0000       0.0000
                           _cons | -.39272387   -.38596767   -.38979855
                                   |  .22046332    .22660269    .22829931
                                   |     0.0749       0.0885       0.0877
----------------------------------+-------------------------------------------
cas1_1                            |
                            cons |  3.9047238    3.8868616    3.8851496
                                   |  .27414577    .26850628    .26867348
                                   |     0.0000       0.0000       0.0000
----------------------------------+-------------------------------------------
cas1_2                            |
                     lagpctlib_use |  3.3436029    3.3329991    3.3345159
                                   |  .30571974    .30443987    .30496215
                                   |     0.0000       0.0000       0.0000
----------------------------------+-------------------------------------------
cas1_2_1                          |
                           _cons |  .12037866    .12164403      .119327
                                   |  .40697491     .4042363    .40362999
                                   |     0.7674       0.7635       0.7675
----------------------------------+-------------------------------------------
f1                                |
                  salience_nyt_cen |  1.3087985    1.3005355    1.3042134
                                   |  .53243653    .53845044    .54107965
                                   |     0.0140       0.0157       0.0159
                   complex_3pt_cen | -.23641807   -.23030577   -.23172214
                                   |  .91949432    .93965606    .94469984
                                   |     0.7971       0.8064       0.8062
                  lnissuecount_cen |   .0830284    .08238374    .08341868
                                   |  .21363707    .22026835    .22284323
                                   |     0.6975       0.7084       0.7082
                    infoenv_01_cen | -3.2768549   -3.2372372   -3.2487924
                                   |  2.4414709    2.4672407    2.4796085
                                   |     0.1795       0.1895       0.1901
                       usamicus_cen | -1.2216683   -1.2033215   -1.2095659
```

| | | | |
|---|---|---|---|
| | .55349651 | .56258063 | .56695643 |
| | 0.0273 | 0.0324 | 0.0329 |
| usparty_cen | -1.6855654 | -1.6638382 | -1.6713425 |
| | .58330776 | .59268672 | .59686642 |
| | 0.0039 | 0.0050 | 0.0051 |
| statutory_cen | .20317709 | .20579869 | .20441877 |
| | .45585559 | .46632308 | .47066661 |
| | 0.6558 | 0.6590 | 0.6641 |
| f2 | | | |
| salience_nyt_cen | 1.4321357 | 1.4270938 | 1.4280513 |
| | .63688317 | .63558729 | .63648104 |
| | 0.0245 | 0.0247 | 0.0249 |
| complex_3pt_cen | -.37590127 | -.37517886 | -.3744169 |
| | 1.0727686 | 1.0706272 | 1.0717017 |
| | 0.7260 | 0.7260 | 0.7268 |
| lnissuecount_cen | .52559336 | .52337804 | .52371888 |
| | .25446341 | .25367009 | .25423543 |
| | 0.0389 | 0.0391 | 0.0394 |
| infoenv_01_cen | -.23535991 | -.24728057 | -.24405967 |
| | 2.9681077 | 2.9606287 | 2.9653711 |
| | 0.9368 | 0.9334 | 0.9344 |
| usamicus_cen | -.7769956 | -.77136087 | -.77295672 |
| | .6769883 | .67531714 | .67646903 |
| | 0.2511 | 0.2534 | 0.2532 |
| usparty_cen | -1.3340209 | -1.3306189 | -1.3306759 |
| | .70159345 | .7000968 | .70095192 |
| | 0.0572 | 0.0574 | 0.0576 |
| statutory_cen | -.6900348 | -.68659908 | -.68781565 |
| | .54179413 | .54078971 | .54172083 |
| | 0.2028 | 0.2042 | 0.2042 |
| Statistics | | | |
| N | 3544 | 3544 | 3544 |
| ll | -1433.9496 | -1434.0637 | -1434.0918 |
| aic | 2905.8993 | 2906.1274 | 2906.1837 |

legend: b/se/p