# Multi-level model analysis of the Knowledge and Skills scale of the NAEP 1986 math data (final report)

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# 1 Aim of the project

The aim of this project was to assess the feasibility of analyzing NAEP-scale data using multi-level models to represent the clustering of the NAEP sample design at all four levels: PSUs, schools, students and items, and to compare the results where possible with reported results from 1986.

# 2 Summary

The study established that the multi-level model analysis of NAEP-scale data allows properly for the survey design, gives efficient and correct standard errors, and is computationally feasible. Computing times with the Gllamm package in Stata were substantial for the three-level models, and very substantial for the four-level models: efficient algorithms (for example, a parallelized form of the EM algorithm) are essential for the routine multi-level analysis of NAEP-scale data.

In more detail:

- the 2PL models had higher maximized log-likelihoods than the corresponding MIMIC models at all levels, and both had much higher log-likelihoods than the Rasch model: the four-level 2PL model provided the best representation of the test data, with the three-level 2PL model very little worse;
- the two-level models (ignoring the PSU- and school-level clustering) gave seriously biased estimates of the black-white difference, and underestimated standard errors for all the reporting group parameters except sex and ethnic group;
- the three-level models were sufficient to give correctly specified estimates and standard errors for the reporting group variables except for the standard errors for the region and size and type of community parameters which were slightly underestimated;
- the fourth level had a very small (though non-zero) variance component, which had only slight effects on the estimates and standard errors of the parameters at the upper levels, relative to those from the three-level model;
- the standard errors of the reporting group parameter estimates were substantially larger than those from the (unpublished) 1986 reporting group comparisons;
- the item intercept parameter estimates in all the models at all levels were extremely highly inter-correlated; this is one of the main computational difficulties in maximum likelihood for these models.

## 3 Data and model specification

There were 21,287 Grade 3/Age 9 students in the survey, but only about half of these had responses on any of the items on the Knowledge and Skills scale, so the "full" data set for this scale has 10,463 students clustered in 440 schools, which are themselves clustered in 94 PSUs. High-minority schools were over-sampled to ensure adequate minority student samples. This over-sampling does not require weighting in the analysis as both the school identifier and the student ethnicity are retained in all model analyses except those using the two-level model, in which the school is not identified.

The number of students per school varied from 5 to about 45, with an average of 24, and there was an average of 7 items answered per student. The item responses were coded 0 or 1 according to the manual, with items skipped coded zero and items not reached treated as missing and omitted from the data set.

We used a minimal set of reporting variables: sex, race (6 levels), region (4), size and type of community (stoc, 7) and parents education level (pared, 6), to give us some feel for the results. We used a main effect model with 20 dummy variables for these categorical variables.

The data CD had only the scrambled PSU identifier, which is essentially a school identifier - we could identify only a three-level model of schools, students and items. We later received the unscrambled code from ETS which allowed the 4-level analyses.

In analyzing the test data, we evaluated the three main item response models: the Rasch, 2PL and MIMIC models. The Rasch is not generally used for NCES test items but is of historical interest and provides a base for assessing the value of the discrimination parameters in the two- parameter models. The 2PL and MIMIC models have different forms for the regression and in an earlier report we noted that, although the models have the same number of parameters, they can be distinguished with sufficient data.

### 3.1 Two-level models

For student $i$ with latent ability $z_i$ (assumed one-dimensional) on the items of the test scale, and covariates (reporting group variables) $\mathbf{x}_i$, attempting item $j$ and giving the binary responses $y_{ij}$ with probabilities $p_{ij}$ for a correct answer, the Rasch model has the form

$$\begin{aligned} \operatorname{logit} p_{ij} \mid z_i &= \alpha_j + z_i \\ z_i &\sim N(\boldsymbol{\gamma}'\mathbf{x}_i, \sigma^2) \end{aligned}$$

where $\boldsymbol{\gamma}$ is the vector of regression coefficients – the *reporting group parameters*. In this formulation the latent ability is regressed on the explanatory variables, but we can transfer the regression model to the logit scale, by defining

$$\begin{aligned} z_i' &= z_i - \boldsymbol{\gamma}'\mathbf{x}_i, \\ z_i &= z_i' + \boldsymbol{\gamma}'\mathbf{x}_i \end{aligned}$$

and then dropping the prime from $z_i'$, to obtain the Rasch model in the form

$$\begin{aligned} \operatorname{logit} p_{ij} \mid z_i &= \alpha_j + z_i + \boldsymbol{\gamma}'\mathbf{x}_i \\ z_i &\sim N(0, \sigma^2). \end{aligned}$$

Now ability has a homogeneous distribution, and the explanatory variables, through the regression model, affect directly the (logit of the) probability of a correct answer. These two formulations of the Rasch model are equivalent and indistinguishable.

The 2PL model has the form

$$\begin{aligned} \operatorname{logit} p_{ij} \mid z_i &= \alpha_j + \beta_j z_i + \boldsymbol{\gamma}'\mathbf{x}_i \\ z_i &\sim N(0, \sigma^2), \end{aligned}$$

and the MIMIC model has the form

$$\begin{aligned} \operatorname{logit} p_{ij} \mid z_i &= \alpha_j + \beta_j z_i \\ z_i &\sim N(\boldsymbol{\gamma}'\mathbf{x}_i, \sigma^2), \end{aligned}$$

or, by transferring the regression model to the logit scale as above:

$$\begin{aligned} \operatorname{logit} p_{ij} \mid z_i &= \alpha_j + \beta_j z_i + \beta_j \boldsymbol{\gamma}'\mathbf{x}_i \\ z_i &\sim N(0, \sigma^2). \end{aligned}$$

The MIMIC model has the regression model with the reporting group variables "inside" the student ability distribution; the 2PL model has it "outside", in the logit model for the item responses. In the Rasch and 2PL models the effects of the reporting group variables and individual items are *additive* on the logit scale, whereas in the MIMIC model item slopes *interact* with the reporting group variables on the logit scale, so that the effects of the reporting group variables on the item response probabilties are scaled by the item discriminations and so are *different* for each item.

The first form of the Rasch and MIMIC models has the strong property that, given ability, the item response probabilities *do not depend on the explanatory variables.* The second form however does *not* have this property – the explanatory variables now appear explicitly in the logit of the item response probabilties. Since the two forms of the models are interchangeable, this makes clear that the usual definition of item bias – that, given ability, the item response probabilities are different for different reporting groups – is not a satisfactory definiton, and that some form of *interaction* definition is needed.

The MIMIC model (the name comes from structural equation models : Multiple Indicators and MultIple Causes of a single latent variable) is the standard model currently used in the analysis of NAEP data – it is usually called the "2PL model" in the IRT literature. Skrondal and Rabe-Hesketh (2004) discuss these models in detail.

The 2PL and MIMIC models are identical when the regression model is null, that is when $\boldsymbol{\gamma} = \mathbf{0}$, but are in general different, though they have the same number of parameters. The two models can be discriminated with sufficient data.

### 3.2 Three-level models

The three-level models include an additional random effect $\eta_k$ for the effect of school $k$. We give the models in the alternative form with a zero mean for the ability random effect $z_i$. For the Rasch model,

$$\begin{aligned} \operatorname{logit} p_{ijk} \mid z_i, \eta_k &= \alpha_j + z_i + \boldsymbol{\gamma}'\mathbf{x}_i + \eta_k \\ z_i &\sim N(0, \sigma^2) \\ \eta_k &\sim N(0, \sigma^2_{sch}), \end{aligned}$$

for the 2PL model

$$\begin{aligned} \operatorname{logit} p_{ij} \mid z_i, \eta_k &= \alpha_j + \beta_j z_i + \boldsymbol{\gamma}'\mathbf{x}_i + \eta_k \\ z_i &\sim N(0, \sigma^2) \\ \eta_k &\sim N(0, \sigma^2_{sch}) \end{aligned}$$

and for the MIMIC model,

$$\begin{aligned} \operatorname{logit} p_{ijk} \mid z_i, \eta_k &= \alpha_j + \beta_j z_i + \beta_j \boldsymbol{\gamma}'\mathbf{x}_i + \beta_j \eta_k \\ z_i &\sim N(0, \sigma^2) \\ \eta_k &\sim N(0, \sigma^2_{sch}). \end{aligned}$$

### 3.3 Four-level models

The four-level model adds a PSU-level random effect $\epsilon_\ell$ for the effect of PSU $\ell$; the notation for the school effect changes to $\eta_{kl}$ for the effect of school $k$ in PSU $\ell$, and the "among schools" variance component for schools in the three-level model is decomposed into an "among PSU" component and an "among school within PSU" component.

For the Rasch model,

$$\begin{aligned} \operatorname{logit} p_{ijk\ell} \mid z_i, \eta_{k\ell}, \epsilon_\ell &= \alpha_j + z_i + \boldsymbol{\gamma}'\mathbf{x}_i + \eta_{k\ell} + \epsilon_\ell \\ z_i &\sim N(0, \sigma^2) \\ \eta_{k\ell} &\sim N(0, \sigma^2_{sch}) \\ \epsilon_\ell &\sim N(0, \sigma^2_{PSU}); \end{aligned}$$

for the 2PL model

$$\begin{aligned}
\operatorname{logit} p_{ijk\ell} \mid z_i, \eta_{k\ell}, \epsilon_\ell &= \alpha_j + \beta_j z_i + \boldsymbol{\gamma}'\mathbf{x}_i + \eta_{k\ell} + \epsilon_\ell \\
z_i &\sim N(0, \sigma^2) \\
\eta_k &\sim N(0, \sigma^2_{sch}) \\
\epsilon_\ell &\sim N(0, \sigma^2_{PSU}),
\end{aligned}$$

and for the MIMIC model,

$$\begin{aligned}
\operatorname{logit} p_{ijk\ell} \mid z_i, \eta_{k\ell}, \epsilon_\ell &= \alpha_j + \beta_j z_i + \beta_j \boldsymbol{\gamma}'\mathbf{x}_i + \beta_j \eta_{k\ell} + \beta_j \epsilon_\ell \\
z_i &\sim N(0, \sigma^2) \\
\eta_{k\ell} &\sim N(0, \sigma^2_{sch}) \\
\epsilon_\ell &\sim N(0, \sigma^2_{PSU}).
\end{aligned}$$

The three-and four-level MIMIC models have the same property as in the two-level model: the additional terms in the ability model interact with the item slopes to give differently scaled random effects on the logit scale for each item.

# 4 Analysis

We began the analysis with 2-level Rasch, 2PL and MIMIC models. We ran all 3-level Rasch, 2PL and MIMIC models using the parameter estimates from the corresponding 2-level models as starting values. The 3-level parameter estimates were used as starting values for the corresponding 4-level models.

Null models (items but no reporting group variables) were also fitted to establish the size of the variance components and the importance of the regression.

## 4.1 2- and 3-level models

### 4.1.1 Log-likelihoods

The log-likelihood improvement for the 3-level model over the 2-level model is large in every case – 126 for the Rasch, 147 for the 2PL and 118 for the MIMIC. A formal test (the "chi-bar" test) treats the deviance difference – twice the log-likelihood difference – as a mixture of $\chi^2$ distribution: $0.5\chi^2_0 + 0.5\chi^2_1$. The first component is a degenerate distribution – a discrete "spike" mass of 0.5 at zero: if the null hypothesis is true, the MLE of the variance component is zero about half the time, and so the maximized likelihood under the alternative hypothesis will be the same as that under the null half the time, and the other half it will behave like $\chi^2_1$. The deviance difference vastly exceeds the critical value in all three models. The 2-level model does not provide a correct representation of the clustered survey design.

The 2-level 2PL model fitted the test data somewhat better than the 2-level MIMIC model – a log-likelihood difference of 3.06 – and vastly better than the Rasch model – a log-likelihood difference of 397.96.

For the 3-level model the differences in favour of the 2PL are much greater – 31.63 compared with the MIMIC model and 418.99 with the Rasch model.

### 4.1.2 Variance components

The school variance components at the third level were quite large, relative to the student level variances. These were respectively 0.154 and 1.168 for the Rasch, 0.139 and 1.682 for the 2PL, and 0.135 and 1.065 for the MIMIC.

### 4.1.3 Parameter estimates

The parameter estimates changed substantially at the student level from the 2-level to the 3-level model – the black (compared with white) estimate reduced by 2.5 standard errors for the Rasch model, 2.7 SEs for the 2PL model and 1.6 SEs for the MIMIC model, and the American Indian - white difference reduced by one SE for all three models. The other parameters were more stable, the largest change being one SE for the lomet category of stoc (relative to extreme rural).

The very serious bias of the black-white difference in the 2-level model shows the importance of modeling the design correctly with the school level random effect.

### 4.1.4 Standard errors

The intra-class (school) correlations are 0.117 for the (3-level) Rasch, .076 for the 2PL and .113 for the MIMIC. These are not large values but the corresponding design effects change the standard errors quite substantially – these are increased by 50% relative to those from the 2- level model for variables at the school level (like region and stoc). The standard errors for parents education are also increased by the same proportion, although this is apparently a student-level variable. This probably reflects the homogeneity of educational level amongst parents of children in the same school. The standard errors of the student-level demographic variables are little affected.

## 4.2 4-level models

### 4.2.1 Log-likelihoods

The log-likelihood improvement for the 4-level model over the 3-level model is much smaller than that for the 3- to 2-level model in every case – 6.19

for the Rasch, 5.45 for the 2PL and 7.22 for the MIMIC. The difference is statistically significant at the 0.1% level for all three.

The 2PL model again fitted much better than the MIMIC – a log-likelihood improvement of 29.86 – and vastly better than the Rasch – 418.25. This strongly suggests (although there is no formal Neyman-Pearson test for this model comparison) that the interaction terms on the logit scale in the MIMIC model are unnecessary, and the simpler structure of the 2PL model is preferable to the MIMIC model.

#### 4.2.2 Variance components

The PSU variance components in all three cases, though significant, were very small – 0.036 for the Rasch, 0.019 for the 2PL and 0.032 for the MIMIC.

The small change in log-likelihood, and the very small variance components, suggest that the 3-level model provides a substantially correct representation of the clustered survey design: the variation among PSUs was very small after the variation among schools within PSUs was taken out.

#### 4.2.3 Parameter estimates

The effect of the fourth level estimation on the model parameter estimates was small, with the largest change being 0.33 SE in one stoc parameter. The parents education estimates all increased (relative to the three-level model), by 0.05 for the Rasch model, 0.02 for the 2PL model and 0.04 for the MIMIC. These changes represent 25% of a standard error for the Rasch model, 10% for the 2PL model and 20% for the MIMIC. The gender and ethnic origin parameters and standard errors were very stable from three to four levels.

#### 4.2.4 Standard errors

The effect on the standard errors was also small – the SEs of the region effects increased by about 20%, while those of the parents education *decreased* by about 5%, because the school variance component was reduced by the fourth level modeling.

## 5 Computational issues

Computational times for these models in Gllamm were very substantial. This is partly due to the near-singularity of the information matrix in the more complex models; a singular information matrix in a regression model results from linear dependence in the explanatory variables, and this prevents the inversion of the matrix and the estimation of parameters and their standard errors. The severity of the near-singularity is usually measured by the *condition number* which is reported by Glamm. The condition number is the ratio of the largest to the smallest eigenvalue of the information matrix – the larger the condition number, the closer is the information matrix to singularity.

All the models were badly conditioned except for the Rasch null models. The table below gives the condition number for most of the models: the MIMIC model was consistently the worst-conditioned.

| | Condition numbers | | |
|---|---|---|---|
| | Rasch | 2PL | MIMIC |
| 2-level null | 6.0 | 42.3 | 42.3 |
| 3-level null | 11.0 | 36.7 | |
| 4-level null | 12.7 | 37.1 | |
| 2-level full | 63.0 | 70.5 | 75.4 |
| 3-level full | 83.3 | 67.9 | 106.4 |
| 4-level full | 83.0 | 83.2 | 101.4 |

## 6 Presentation of parameter estimates and SEs

Results for all models are given in Appendix 1. The reporting group parameter estimates are given on the N(0,1) latent ability scale (for the Rasch and MIMIC models) or the logit scale (for the Rasch and 2PL models). For the Rasch model the scales are identical.

## 7 Relation of modeling results to unpublished ETS tables

The ETS tables relevant to our results are the one-way tabulations of plausible values by (total, Gender, Race/ethnicity, School Type, Parental Education, Region). Our model used Size and Type of Community (stoc), and not School Type.

The one-way tabulations will in general give different results from the main effect model estimates since any correlation between the reporting group variables will affect the marginal mean differences. (This is the reason for fitting all reporting groups together in a main effect regression model.)

To compare the results, we present the ETS tables in the same form as the MIMIC model parameters, with the reference category mean subtracted, and standard errors calculated from the variances of the difference between the means. We rescale the MIMIC parameters to the NAEP reporting scale with an origin of 250.5 and standard deviation 50, for the reference category of the dummy variables (male, white, region 1, stoc 1, pred 1).

| | ETS table results | | MIMIC model estimates | |
|---|---|---|---|---|
| Variable | Estimate | SE | MLE | SE |
| Male | 0 | | 0 | |
| Female | 2.2 | 1.5 | 6.2 | 1.6 |
| White | 0 | | 0 | |
| Black | -31.1 | 2.1 | -32.6 | 4.1 |
| Hispanic | -22.4 | 2.4 | -23.2 | 3.2 |
| Asian/Pacific Islander | - 3.5 | 5.9 | - 8.3 | 6.3 |
| American Indian | -13.0 | 3.4 | -24.3 | 5.8 |
| other | 5.5 | 16.9 | 8.3 | 35.8 |
| NorthEast | 0 | | 0 | |
| SouthEast | - 2.4 | 2.1 | - 3.8 | 3.9 |
| Central | - 1.3 | 2.3 | - 9.8 | 3.8 |
| West | - 4.6 | 2.5 | - 9.7 | 3.5 |
| ExtremeRural | | | 0 | |
| Lo Metrop | | | -16.0 | 6.3 |
| Hi Metrop | | | 22.3 | 6.6 |
| MainCity | | | 6.5 | 6.0 |
| UrbanFringe | | | 8.5 | 6.2 |
| MediumCity | | | 4.9 | 5.7 |
| SmallPlace | | | - 2.2 | 5.4 |
| NotFinHiSch | 0 | | 0 | |
| FinHiSch | 7.8 | 4.0 | - 1.0 | 10.9 |
| SomeColl | 22.8 | 4.3 | 8.4 | 10.6 |
| CollGrad | 24.9 | 3.8 | 28.5 | 11.2 |
| DontKnow | 13.1 | 3.7 | 27.7 | 10.9 |
| NoResponse | - 5.2 | * | 10.4 | 10.5 |

* SE not given

# 8 Reporting group differences from modeling and from the unpublished 1986 tables

Some reporting group differences are quite similar in the two approaches. The Black-White and Hispanic-White group differences based on large samples agree closely, and those based on small samples do not differ by more than one standard error except the American Indian group. However the other variables do not show good agreement, and there are some large differences in parental education groups, with the ETS tables giving equivalent means for "some college" and "college graduate" levels, while the ML analysis shows college graduates 20 points above the "some college" group, and much closer to the "don't know" group.

These differences may be due partly to the substantial differences in the item parameter estimates in the two analyses, discussed further below. Another possibility, as noted above, may be the difference between marginal tabulations (by each of two variables) and the two-way tabulation by the same two variables, or by a full main-effect model-based analysis, depending on the correlation between the tabulating variables. This raises an important issue of how these differences should be assessed and reported; the occurrence of Simpson's paradox in such marginal tabulations is well-documented and always important to assess.

Of greater concern are the very substantial differences in standard errors. Those reported in the ETS tables, apart from sex, are around half those found from the 3-level ML analysis; the ETS standard errors are much closer to those from the 2-level model analysis ignoring the PSU and school clustering. The reason for this is unclear, but it is certainly not that the 3-level ML analysis ignores the clustering: the intra-class correlation is estimated at 0.11, and this automatically adjusts the standard errors for the cluster design. The clustering affects mainly the upper-level variables in the model: standard errors of the upper-level variables are nearly 50% larger in the 3-level analysis than in the 2-level analysis.

Nor is the reason the use of the full reporting group model in the ML analysis: if a set of explanatory variables are highly correlated, the standard errors for the parameter estimates from the full regression model may be much larger than those from the regressions with each single variable. There are certainly some correlations among the ethnicity, type of community and parents education variables, and this possibility can be assessed by examining the correlation matrix of the parameter estimates. This is given for the 3-level Rasch model in Appendix 4 and the four-level 2PL model in Appendix 5. The correlations of the reporting group parameter estimates are very low, apart from the positive inter-correlations for the parameters for each category of a single variable. So the fitting of the full reporting group model does not induce the large standard errors for this model.

Another possibility is the approximation used to compute sampling variances of subgroup means used in the NAEP technical report and in the ETS tables. The differences in standard errors warrant further investigation.

# 9 Summary of reporting group parameters from the model

The parameter estimates from the above table are interpreted here for the MIMIC model:

- Girls have a slightly higher mean than boys;
- Blacks, Hispanics and American Indians have much lower means than Whites, Asian/ Pacific Islanders are somewhat below Whites, though not significantly, and "others" are similar to Whites;
- the SouthEast region is similar to NorthEast while West and Center are lower and similar;
- Low Metropolitan is substantially lower than Extreme Rural; High Metropolitan is much higher; Main City, Urban Fringe, Medium City and Small Place are similar to Extreme Rural;
- Students whose parents had less than a full college degree have similar means, and similar to the No Response group. The Don't Know group are similar to the College Graduate group and have much higher means than the other groups.

# 10 Item parameter estimates

We give in Appendix 2 the item parameters from the three sets of models. A notable feature of the Rasch item parameter estimates is their *invariance* across the different models – the 2-level, 3-level and 4-level models, whether full or null, have essentially the same parameter estimates. Their standard errors however are increased substantially in the full 2-level model compared to the null model (because of the correlations between parameter estimates discussed below), and increase further in the full 3-level model (because of the substantial school design effect), but do not increase further in the 4-level model (because of the very small PSU design effect).

The Rasch item parameter estimates from different models differ only by an origin term, and are given in the appendix with an origin shift so that they all have the same average difficulty. This strong invariance led us to investigate the correlation matrix of the item parameters and reporting group parameters. In an earlier draft of this report we conjectured that the

Rasch model information matrix (and therefore the correlation matrix of the estimated parameters) was block-diagonal. This matrix is available as part of the program output, and is shown (to 3 dp) for the Rasch model in Appendix 4.

There is a strikingly high intercorrelation of the item intercepts, averaging nearly 0.95, with much lower correlations between item parameters and reporting group parameters, except for the parents education parameters which are correlated around -0.8 with the item parameters. However the matrix is *not* block-diagonal, and the reason for the stability of the Rasch item estimates is probably the existence of sufficient statistics for both item parameters and reporting group parameters.

The very high inter-correlations of the item parameter estimates explains the high condition number, and the difficulty in maximizing the likelihood for both the Rasch model and the much more complex MIMIC and 2PL models; we show the correlation matrix for the 4-level 2PL model in Appendix 5. The item intercepts show a very similar pattern to those in the Rasch model, but the slopes are almost uncorrelated with both the intercepts and the reporting group parameters; the slopes are themselves moderately intercorrelated, with an average correlation of about 0.6.

The 4-level MIMIC model had a non-positive definite information matrix, and the correlation matrix of the estimated parameters could not be computed because of zero or negative values of the variances on the main diagonal of the parameter covariance matrix. This result and the higher log-likelihood of the 2PL model suggest that the 2PL model is preferable to the MIMIC model for these data.

# 11 Comparison of item parameters estimated from ETS and ML

The item parameters $a_j, b_j$ and $c_j$ reported by ETS are shown in Appendix 3, with the 3-level MIMIC estimates from the present analysis rescaled to correspond to the ETS coding: since

$$a_j(z - b_j) = \alpha_j + \beta_j z,$$

we have

$$a_j = \beta_j,\ b_j = -\alpha_j/\beta_j.$$

Some of the items use the 3PL model with the $c_j$ guessing parameter, and so are not comparable with the two-parameter models used in our analysis. The two sets of estimates differ very considerably; this is due partly to the difference between the "separate" and "joint" estimation methods used in 1986 and the ML analysis, partly to our adjustment for the clustered survey design, and partly to different codings used for "intentional omissions". In our analysis, following the manual, we coded these as incorrect (0), whereas the User Guide 1986 states that these were coded as "partially correct", with value the reciprocal of the number of alternatives.

The difference in standard errors for the $a$ parameters is even greater: the median SE for the ETS $a$ estimates is .025, that for the ML estimates is .134, more than five times as large. The reason for this is unclear – the ETS estimates were produced by LOGIST on the same data. The different coding for intentional omissions is unlikely to be responsible.

## 12 Acknowledgements

This work was carried out with the use of the computers of the Victorian Partnership for Advanced Computing, and with assistance from the High Performance Computing Group at the University of Melbourne. We appreciate advice from Sophia Rabe-Hesketh on the use of Gllamm.

## 13 References

Skrondal, A. and Rabe-Hesketh, S. (2004) *Generalized Latent Variable Modeling: Multilevel, Longitudinal and Structural Relations Models.* Chapman and Hall/CRC, Boca Raton, FL.

# 14 Appendix 1 – model parameter estimates and SEs

Rasch variance component estimates and SEs for the null models

| | 2-level | 3-level | 4-level |
|---|---|---|---|
| s^2_PSU | 0 | 0 | .059(.016) |
| s^2_sch | 0 | .325(.029) | .257(.024) |
| s^2 | 1.558(.043) | 1.246(.038) | 1.243(.038) |
| log L | -40,977.29 | -40,605.49 | -40,601.08 |

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2PL variance component estimates and SEs for the null models

| | 2-level | 3-level | 4-level |
|---|---|---|---|
| s^2_PSU | 0 | 0 | .033(.013) |
| s^2_sch | 0 | .285(.026) | .212(.019) |
| s^2 | 1.574(.320) | 1.665(.358) | 1.634(.350) |
| log L | -40,559.10 | -40,183.23 | -40,180.08 |

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Rasch, MIMIC and 2PL estimates and SEs for the 2-level model

| | Rasch | MIMIC | 2PL |
|---|---|---|---|
| male | 0 | 0 | 0 |
| femal | .111(.031) | .121(.033) | .015(.028) |
| | | | |
| white | 0 | 0 | 0 |
| black | -.830(.045) | -.780(.090) | -.792(.041) |
| hispa | -.546(.045) | -.526(.069) | -.514(.041) |
| as/pa | -.214(.126) | -.188(.117) | -.240(.114) |
| amind | -.599(.113) | -.619(.121) | -.588(.092) |
| other | -.121(.783) | .230(.672) | -.380(.855) |
| | | | |
| NE | 0 | 0 | 0 |
| SE | -.033(.051) | -.045(.049) | .003(.046) |
| Cent | -.245(.051) | -.230(.055) | -.219(.046) |
| West | -.209(.046) | -.213(.049) | -.193(.042) |
| | | | |
| extru | 0 | 0 | 0 |
| lomet | -.224(.083) | -.207(.085) | -.126(.075) |
| himet | .508(.081) | .505(.094) | .475(.074) |
| manct | .141(.079) | .174(.079) | .133(.072) |
| urbfr | .161(.081) | .173(.082) | .121(.074) |
| medct | .079(.074) | .079(.073) | .031(.067) |
| smplc | -.066(.072) | -.036(.072) | -.055(.066) |
| | | | |
| nfnhs | 0 | 0 | 0 |
| finhs | -.105(.159) | -.086(.154) | -.205(.152) |
| smcol | .120(.146) | .145(.140) | .061(.141) |
| colgr | .593(.154) | .595(.160) | .460(.149) |
| DK | .591(.142) | .594(.149) | .453(.138) |
| nores | .165(.141) | .194(.136) | .047(.137) |
| | | | |
| s^2 | 1.311(.039) | 1.185(.244) | 1.646(.345) |
| logL | -40,475.22 | -40,080.32 | -40,077.26 |

Rasch, MIMIC and 2PL estimates and SEs for the 3-level model

| | Rasch | MIMIC | 2PL |
|---|---|---|---|
| male | 0 | 0 | 0 |
| femal | .107(.031) | .124(.032) | .012(.028) |
| | | | |
| white | 0 | 0 | 0 |
| black | -.703(.050) | -.652(.082) | -.667(.047) |
| hispa | -.492(.047) | -.464(.065) | -.460(.043) |
| as/pa | -.196(.129) | -.167(.126) | -.203(.117) |
| amind | -.489(.106) | -.487(.117) | -.471(.093) |
| other | -.054(.718) | .167(.717) | -.200(.752) |
| | | | |
| NE | 0 | 0 | 0 |
| SE | -.056(.081) | -.077(.078) | -.020(.077) |
| Cent | -.204(.080) | -.196(.077) | -.172(.074) |
| West | -.204(.074) | -.194(.071) | -.182(.069) |
| | | | |
| extru | 0 | 0 | 0 |
| lomet | -.310(.127) | -.319(.127) | -.201(.113) |
| himet | .511(.125) | .447(.133) | .497(.116) |
| manct | .143(.119) | .131(.120) | .150(.106) |
| urbfr | .188(.125) | .171(.125) | .158(.112) |
| medct | .113(.112) | .098(.114) | .092(.097) |
| smplc | -.038(.108) | -.045(.109) | -.019(.095) |
| | | | |
| nfnhs | 0 | 0 | 0 |
| finhs | -.033(.216) | -.020(.219) | -.179(.206) |
| smcol | .186(.208) | .168(.213) | .045(.200) |
| colgr | .607(.214) | .570(.225) | .398(.205) |
| DK | .588(.206) | .554(.218) | .382(.198) |
| nores | .221(.205) | .209(.211) | .027(.197) |
| | | | |
| s^2_sch | .154(.019) | .135(.032) | .139(.017) |
| s^2 | 1.168(.037) | 1.065(.219) | 1.682(.365) |
| logL | -40,349.04 | -39,961.68 | -39,930.05 |

Rasch, MIMIC and 2PL estimates and SEs for the 4-level model

| | Rasch | MIMIC | 2PL |
|---|---|---|---|
| male | 0 | 0 | 0 |
| femal | .107(.031) | .124(.032) | .012(.028) |
| | | | |
| white | 0 | 0 | 0 |
| black | -.707(.050) | -.657(.082) | -.670(.046) |
| hispa | -.491(.047) | -.462(.065) | -.454(.043) |
| as/pa | -.199(.129) | -.176(.127) | -.206(.116) |
| amind | -.493(.105) | -.494(.115) | -.471(.093) |
| other | -.043(.717) | .198(.721) | -.174(.739) |
| | | | |
| NE | 0 | 0 | 0 |
| SE | -.050(.095) | -.071(.088) | -.036(.080) |
| Cent | -.203(.098) | -.180(.096) | -.176(.087) |
| West | -.184(.089) | -.184(.083) | -.198(.077) |
| | | | |
| extru | 0 | 0 | 0 |
| lomet | -.300(.126) | -.332(.123) | -.189(.120) |
| himet \| | .471(.127) | .408(.123) | .481(.119) |
| manct | .137(.123) | .134(.114) | .188(.121) |
| urbfr | .179(.125) | .167(.117) | .176(.122) |
| medct | .069(.103) | .069(.108) | .061(.110) |
| smplc | -.052(.107) | -.064(.100) | -.026(.102) |
| | | | |
| nfnhs | 0 | 0 | 0 |
| finhs | .017(.213) | .018(.211) | -.153(.201) |
| smcol | .234(.205) | .203(.205) | .065(.194) |
| colgr | .655(.211) | .608(.219) | .422(.199) |
| DK | .636(.202) | .592(.211) | .403(.192) |
| nores | .270(.202) | .245(.203) | .048(.191) |
| | | | |
| s^2_PSU | .036(.013) | .032(.014) | .019(.010) |
| s^2_sch | .116(.019) | .108(.028) | .119(.017) |
| s^2 | 1.169(.037) | 1.078(.221) | 1.653(.360) |
| logL | -40,342.85 | -39,954.46 | -39,924.60 |

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Rasch estimates and SEs for the 2-, 3- and 4-level models

| | 2-level | 3-level | 4-level |
|---|---|---|---|
| male | 0 | 0 | 0 |
| femal | .111(.031) | .107(.031) | .107(.031) |
| | | | |
| white | 0 | 0 | 0 |
| black | -.830(.045) | -.703(.050) | -.707(.050) |
| hispa | -.546(.045) | -.492(.047) | -.491(.047) |
| as/pa | -.214(.126) | -.196(.129) | -.199(.129) |
| amind | -.599(.113) | -.489(.106) | -.493(.105) |
| other | -.121(.783) | -.054(.718) | -.043(.717) |
| | | | |
| NE | 0 | 0 | 0 |
| SE | -.033(.051) | -.056(.081) | -.050(.095) |
| Cent | -.245(.051) | -.204(.080) | -.203(.098) |
| West | -.209(.046) | -.204(.074) | -.184(.089) |
| | | | |
| extru | 0 | 0 | 0 |
| lomet | -.224(.083) | -.310(.127) | -.300(.126) |
| himet | .508(.081) | .511(.125) | .471(.127) |
| manct | .141(.079) | .143(.119) | .137(.123) |
| urbfr | .161(.081) | .188(.125) | .179(.125) |
| medct | .079(.074) | .113(.112) | .069(.113) |
| smplc | -.066(.072) | -.038(.108) | -.052(.107) |
| | | | |
| nfnhs | 0 | 0 | 0 |
| finhs | -.105(.159) | -.033(.216) | .017(.213) |
| smcol | .120(.146) | .186(.208) | .234(.205) |
| colgr | .593(.154) | .607(.214) | .655(.211) |
| DK | .591(.142) | .588(.206) | .636(.202) |
| nores | .165(.141) | .221(.205) | .270(.202) |
| | | | |
| s^2_PSU | 0 | 0 | .036(.013) |
| s^2_sch | 0 | .154(.019) | .116(.019) |
| s^2 | 1.311(.039) | 1.168(.037) | 1.169(.037) |
| logL | -40,475.22 | -40,349.04 | -40,342.85 |

MIMIC estimates and SEs for the 2-, 3- and 4-level models

| | 2-level | 3-level | 4-level |
|---|---|---|---|
| male | 0 | 0 | 0 |
| femal | .121(.033) | .124(.032) | .124(.032) |
| white | 0 | 0 | 0 |
| black | -.780(.090) | -.652(.082) | -.657(.082) |
| hispa | -.526(.069) | -.464(.065) | -.462(.065) |
| as/pa | -.188(.117) | -.167(.126) | -.176(.127) |
| amind | -.619(.121) | -.487(.117) | -.494(.115) |
| other | .230(.672) | .167(.717) | .198(.721) |
| | | | |
| NE | 0 | 0 | 0 |
| SE | -.045(.049) | -.077(.078) | -.071(.088) |
| Cent | -.230(.055) | -.196(.077) | -.180(.096) |
| West | -.213(.049) | -.194(.071) | -.184(.083) |
| | | | |
| extru | 0 | 0 | 0 |
| lomet | -.207(.085) | -.319(.127) | -.332(.123) |
| himet | .505(.094) | .447(.133) | .408(.123) |
| manct | .174(.079) | .131(.120) | .134(.114) |
| urbfr | .173(.082) | .171(.125) | .167(.117) |
| medct | .079(.073) | .098(.114) | .069(.108) |
| smplc | -.036(.072) | -.045(.109) | -.064(.100) |
| | | | |
| nfnhs | 0 | 0 | 0 |
| finhs | -.086(.154) | -.020(.219) | .018(.211) |
| smcol | .145(.140) | .168(.213) | .203(.205) |
| colgr | .595(.160) | .570(.225) | .608(.219) |
| DK | .594(.149) | .554(.218) | .592(.211) |
| nores | .194(.136) | .209(.211) | .245(.203) |
| | | | |
| s^2_PSU | 0 | 0 | .032(.014) |
| s^2_sch | 0 | .135(.032) | .108(.028) |
| s^2 | 1.185(.244) | 1.065(.219) | 1.078(.221) |
| logL | -40,080.32 | -39,961.68 | -39,954.46 |

2PL estimates and SEs for the 2-, 3- and 4-level models

| | 2-level | 3-level | 4-level |
|---|---|---|---|
| male | 0 | 0 | 0 |
| femal | .015(.028) | .012(.028) | .012(.028) |
| | | | |
| white | 0 | 0 | 0 |
| black | -.792(.041) | -.667(.047) | -.670(.046) |
| hispa | -.514(.041) | -.460(.043) | -.454(.043) |
| as/pa | -.240(.114) | -.203(.117) | -.206(.116) |
| amind | -.588(.092) | -.471(.093) | -.471(.093) |
| other | -.380(.855) | -.200(.752) | -.174(.739) |
| | | | |
| NE | 0 | 0 | 0 |
| SE | .003(.046) | -.020(.077) | -.036(.080) |
| Cent | -.219(.046) | -.172(.074) | -.176(.087) |
| West | -.193(.042) | -.182(.069) | -.198(.077) |
| | | | |
| extru | 0 | 0 | 0 |
| lomet | -.126(.075) | -.201(.113) | -.189(.120) |
| himet | .475(.074) | .497(.116) | .481(.119) |
| manct | .133(.072) | .150(.106) | .188(.121) |
| urbfr | .121(.074) | .158(.112) | .176(.122) |
| medct | .031(.067) | .092(.097) | .061(.110) |
| smplc | -.055(.066) | -.019(.095) | -.026(.102) |
| | | | |
| nfnhs | 0 | 0 | 0 |
| finhs | -.205(.152) | -.179(.206) | -.153(.201) |
| smcol | .061(.141) | .045(.200) | .065(.194) |
| colgr | .460(.149) | .398(.205) | .422(.199) |
| DK | .453(.138) | .382(.198) | .403(.192) |
| nores | .047(.137) | .027(.197) | .048(.191) |
| | | | |
| s^2_PSU | 0 | 0 | .019(.010) |
| s^2_sch | 0 | .139(.017) | .119(.017) |
| s^2 | 1.646(.345) | 1.682(.365) | 1.653(.360) |
| logL | -40,077.26 | -39,930.05 | -39,924.60 |

## 15 Appendix 2 – item parameter estimates

Rasch model intercepts

| Item | null 2-level alpha (SE) | full 2-level alpha (SE) | full 3-level alpha (SE) | full 4-level alpha (SE) |
|---|---|---|---|---|
| 1 | 3.391 (.090) | 3.398 (.180) | 3.400 (.248) | 3.400 (.247) |
| 2 | 1.735 (.058) | 1.747 (.166) | 1.749 (.238) | 1.749 (.238) |
| 3 | -.384 (.049) | -.373 (.163) | -.372 (.236) | -.372 (.236) |
| 4 | .161 (.050) | .166 (.163) | .167 (.236) | .166 (.236) |
| 5 | -.029 (.050) | -.027 (.163) | -.027 (.236) | -.027 (.236) |
| 6 | -.578 (.052) | -.579 (.164) | -.579 (.236) | -.579 (.236) |
| 7 | -.014 (.052) | -.015 (.164) | -.016 (.236) | -.016 (.236) |
| 8 | -3.243 (.092) | -3.251 (.181) | -3.251 (.248) | -3.250 (.248) |
| 9 | .802 (.050) | .805 (.163) | .808 (.236) | .808 (.236) |
| 10 | .316 (.049) | .319 (.163) | .321 (.236) | .321 (.235) |
| 11 | .108 (.049) | .109 (.163) | .111 (.236) | .111 (.235) |
| 12 | .685 (.050) | .685 (.163) | .687 (.236) | .687 (.236) |
| 13 | -.668 (.050) | -.667 (.163) | -.666 (.236) | -.666 (.236) |
| 14 | -.425 (.050) | -.425 (.163) | -.425 (.236) | -.425 (.236) |
| 15 | -.215 (.050) | -.216 (.163) | -.216 (.236) | -.215 (.236) |
| 16 | .733 (.058) | .722 (.165) | .720 (.238) | .721 (.237) |
| 17 | -2.163 (.073) | -2.175 (.172) | -2.180 (.242) | -2.180 (.242) |
| 18 | -.987 (.062) | -1.000 (.167) | -1.005 (.238) | -1.004 (.238) |
| 19 | .915 (.064) | .885 (.168) | .876 (.239) | .876 (.239) |
| 20 | .479 (.065) | .448 (.169) | .434 (.239) | .434 (.239) |
| 21 | 1.657 (.057) | 1.669 (.165) | 1.672 (.237) | 1.673 (.237) |
| 22 | 1.636 (.057) | 1.647 (.165) | 1.650 (.237) | 1.651 (.237) |
| 23 | .338 (.049) | .349 (.163) | .353 (.236) | .353 (.235) |
| 24 | .976 (.052) | .987 (.164) | .990 (.236) | .990 (.236) |
| 25 | -.689 (.051) | -.684 (.164) | -.682 (.236) | -.682 (.236) |
| 26 | -.551 (.053) | -.549 (.164) | -.550 (.236) | -.550 (.236) |
| 27 | -2.097 (.067) | -2.100 (.169) | -2.101 (.240) | -2.101 (.240) |
| 28 | -1.358 (.064) | -1.360 (.169) | -1.358 (.239) | -1.359 (.239) |
| 29 | .408 (.049) | .421 (.163) | .422 (.235) | .421 (.235) |
| 30 | .024 (.051) | .027 (.163) | .024 (.236) | .024 (.236) |
| origin | 0 | -.020 | -.118 | -.077 |

MIMIC model slopes

| Item | null 2-level beta (SE) | full 2-level beta (SE) | full 3-level beta (SE) | full 4-level beta (SE) |
|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 |
| 2 | 1.015 (.122) | 1.037 (.125) | 1.035 (.124) | 1.025 (.123) |
| 3 | .898 (.109) | .908 (.110) | .899 (.109) | .889 (.107) |
| 4 | .992 (.121) | 1.149 (.140) | 1.144 (.138) | 1.137 (.137) |
| 5 | .848 (.104) | .945 (.115) | .945 (.115) | .940 (.114) |
| 6 | 1.023 (.126) | 1.079 (.132) | 1.101 (.134) | 1.096 (.133) |
| 7 | .952 (.116) | .965 (.118) | .987 (.120) | .982 (.119) |
| 8 | 1.140 (.169) | 1.125 (.165) | 1.149 (.169) | 1.145 (.168) |
| 9 | .696 (.085) | .732 (.090) | .727 (.090) | .724 (.089) |
| 10 | .807 (.096) | .893 (.106) | .910 (.108) | .906 (.107) |
| 11 | .807 (.096) | .861 (.103) | .858 (.102) | .852 (.101) |
| 12 | 1.897 (.219) | 1.951 (.228) | 1.967 (.231) | 1.951 (.228) |
| 13 | 2.170 (.264) | 2.133 (.253) | 2.112 (.251) | 2.098 (.248) |
| 14 | 1.885 (.221) | 1.874 (.219) | 1.872 (.219) | 1.857 (.217) |
| 15 | .507 (.066) | .561 (.073) | .564 (.073) | .560 (.072) |
| 16 | 1.005 (.121) | 1.093 (.132) | 1.131 (.136) | 1.126 (.135) |
| 17 | 1.135 (.146) | 1.206 (.155) | 1.229 (.158) | 1.223 (.157) |
| 18 | .954 (.117) | 1.045 (.129) | 1.055 (.130) | 1.050 (.129) |
| 19 | 1.159 (.155) | 1.325 (.175) | 1.325 (.173) | 1.316 (.171) |
| 20 | 1.099 (.149) | 1.169 (.157) | 1.185 (.158) | 1.178 (.157) |
| 21 | 1.796 (.223) | 1.665 (.201) | 1.609 (.194) | 1.597 (.192) |
| 22 | 1.845 (.227) | 1.735 (.209) | 1.662 (.200) | 1.651 (.198) |
| 23 | 1.332 (.157) | 1.426 (.169) | 1.414 (.167) | 1.402 (.165) |
| 24 | 1.009 (.120) | 1.132 (.135) | 1.135 (.135) | 1.129 (.134) |
| 25 | .977 (.118) | 1.114 (.135) | 1.171 (.141) | 1.165 (.140) |
| 26 | 1.002 (.123) | 1.082 (.132) | 1.083 (.132) | 1.075 (.131) |
| 27 | .219 (.059) | .254 (.063) | .260 (.063) | .258 (.062) |
| 28 | .405 (.087) | .485 (.089) | .511 (.090) | .506 (.089) |
| 29 | .564 (.084) | .604 (.086) | .657 (.091) | .658 (.091) |
| 30 | .617 (.090) | .660 (.094) | .634 (.090) | .629 (.089) |

2PL model slopes

| Item | null 2-level beta (SE) | full 2-level beta (SE) | full 3-level beta (SE) | full 4-level beta (SE) |
|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 |
| 2 | 1.015 (.122) | 1.012 (.126) | .972 (.126) | .978 (.127) |
| 3 | .898 (.109) | .926 (.116) | .915 (.121) | .929 (.123) |
| 4 | .992 (.121) | .715 (.093) | .668 (.091) | .675 (.092) |
| 5 | .848 (.104) | .653 (.086) | .620 (.086) | .628 (.087) |
| 6 | 1.023 (.126) | .831 (.107) | .744 (.101) | .750 (.102) |
| 7 | .952 (.116) | .958 (.123) | .851 (.115) | .857 (.116) |
| 8 | 1.140 (.169) | 1.096 (.171) | 1.027 (.169) | 1.026 (.169) |
| 9 | .696 (.085) | .635 (.081) | .591 (.080) | .597 (.081) |
| 10 | .807 (.096) | .722 (.089) | .628 (.082) | .633 (.083) |
| 11 | .807 (.096) | .753 (.093) | .697 (.090) | .704 (.091) |
| 12 | 1.897 (.219) | 1.757 (.210) | 1.735 (.216) | 1.751 (.219) |
| 13 | 2.170 (.264) | 1.859 (.227) | 1.943 (.251) | 1.959 (.253) |
| 14 | 1.885 (.221) | 1.705 (.205) | 1.787 (.224) | 1.800 (.226) |
| 15 | .507 (.066) | .421 (.060) | .358 (.057) | .359 (.057) |
| 16 | 1.005 (.121) | .944 (.118) | .767 (.103) | .772 (.104) |
| 17 | 1.135 (.146) | 1.011 (.137) | .853 (.124) | .857 (.125) |
| 18 | .954 (.117) | .764 (.100) | .690 (.096) | .696 (.097) |
| 19 | 1.159 (.155) | .989 (.138) | .911 (.133) | .922 (.134) |
| 20 | 1.099 (.149) | .946 (.134) | .876 (.131) | .883 (.132) |
| 21 | 1.796 (.223) | 1.847 (.236) | 1.923 (.255) | 1.932 (.256) |
| 22 | 1.845 (.227) | 1.824 (.231) | 1.934 (.256) | 1.951 (.259) |
| 23 | 1.332 (.157) | 1.161 (.141) | 1.109 (.139) | 1.119 (.141) |
| 24 | 1.009 (.120) | .841 (.105) | .796 (.103) | .803 (.104) |
| 25 | .977 (.118) | .788 (.101) | .672 (.091) | .676 (.092) |
| 26 | 1.002 (.123) | .857 (.110) | .774 (.104) | .780 (.105) |
| 27 | .219 (.059) | .128 (.057) | .091 (.057) | .092 (.058) |
| 28 | .405 (.087) | .320 (.085) | .265 (.084) | .267 (.085) |
| 29 | .564 (.084) | .537 (.084) | .406 (.073) | .409 (.074) |
| 30 | .617 (.090) | .563 (.087) | .552 (.091) | .555 (.092) |

# 16 Appendix 3 – ETS and ML item estimates and SEs

| | ETS | | | ML | |
|---|---|---|---|---|---|
| item | a | b | c | a | b |
| 1 | .503 (.019) | -3.780 (.143) | - | 1.0 | -3.255 |
| 2 | .769 (.017) | -2.066 (.049) | - | 1.035 (.124) | -1.588 |
| 3 | .841 (.018) | -.642 (.019) | - | .899 (.109) | .488 |
| 4 | 1.090 (.045) | -.724 (.044) | .238 | 1.144 (.138) | -.054 |
| 5 | .855 (.023) | -.860 (.032) | - | .945 (.115) | .121 |
| 6 | 1.150 (.065) | -.295 (.040) | .208 | 1.101 (.134) | .634 |
| 7 | 1.162 (.022) | -.848 (.024) | - | .987 (.120) | .111 |
| 8 | 1.738 (.028) | .125 (.018) | - | 1.149 (.169) | 3.027 |
| 9 | .894 (.032) | -.960 (.044) | .280 | .727 (.090) | -.875 |
| 10 | .898 (.047) | -.715 (.050) | .352 | .910 (.108) | -.223 |
| 11 | .886 (.020) | -.900 (.028) | - | .858 (.102) | -.011 |
| 12 | 1.288 (.021) | -1.101 (.025) | - | 1.967 (.231) | -.362 |
| 13 | 1.300 (.025) | -.445 (.017) | - | 2.112 (.251) | .576 |
| 14 | 1.234 (.023) | -.554 (.018) | - | 1.872 (.219) | .424 |
| 15 | .620 (.037) | -.256 (.032) | .225 | .564 (.073) | .416 |
| 16 | .942 (.022) | -1.273 (.039) | - | 1.131 (.136) | -.544 |
| 17 | 1.202 (.059) | .299 (.034) | - | 1.229 (.158) | 1.978 |
| 18 | .865 (.023) | -.047 (.014) | - | 1.055 (.130) | 1.046 |
| 19 | 1.058 (.038) | -1.152 (.053) | .198 | 1.325 (.173) | -.615 |
| 20 | 1.101 (.053) | -.817 (.055) | .257 | 1.185 (.158) | -.275 |
| 21 | .899 (.014) | -1.871 (.034) | - | 1.609 (.194) | -1.181 |
| 22 | .893 (.014) | -1.839 (.033) | - | 1.662 (.200) | -1.148 |
| 23 | 1.017 (.016) | -1.042 (.021) | - | 1.414 (.167) | -.204 |
| 24 | 1.185 (.027) | -1.074 (.034) | .232 | 1.135 (.135) | -.809 |
| 25 | 1.096 (.025) | -.376 (.020) | - | 1.171 (.141) | .687 |
| 26 | .998 (.024) | -.484 (.021) | - | 1.083 (.132) | .591 |
| 27 | 1.766 (.296) | 1.115 (.248) | .197 | .260 (.063) | 6.512 |
| 28 | 1.149 (.034) | .365 (.021) | .164 | .511 (.090) | 2.333 |
| 29 | .955 (.044) | -.544 (.040) | .247 | .657 (.091) | -.449 |
| 30 | .974 (.051) | -.454 (.042) | .243 | .634 (.090) | .072 |

## 17 Appendix 4 – parameter correlation matrix for 3-level Rasch model

| | i1 | i2 | i3 | i4 | i5 |
|---|---|---|---|---|---|
| i1 | 1.0 | | | | |
| i2 | .913 | 1.0 | | | |
| i3 | .917 | .956 | 1.0 | | |
| i4 | .918 | .956 | .964 | 1.0 | |
| i5 | .917 | .955 | .964 | .963 | 1.0 |
| i6 | .915 | .953 | .962 | .962 | .961 |
| i7 | .916 | .954 | .962 | .962 | .962 |
| i8 | .868 | .906 | .916 | .915 | .915 |
| i9 | .913 | .951 | .958 | .958 | .958 |
| i10 | .914 | .952 | .960 | .959 | .959 |
| i11 | .914 | .952 | .960 | .959 | .959 |
| i12 | .913 | .951 | .958 | .958 | .958 |
| i13 | .912 | .950 | .958 | .958 | .958 |
| i14 | .913 | .951 | .959 | .958 | .958 |
| i15 | .913 | .951 | .959 | .959 | .958 |
| i16 | .907 | .944 | .952 | .951 | .951 |
| i17 | .889 | .927 | .935 | .935 | .934 |
| i18 | .903 | .940 | .949 | .948 | .948 |
| i19 | .901 | .938 | .946 | .946 | .945 |
| i20 | .899 | .936 | .944 | .944 | .943 |
| i21 | .908 | .945 | .952 | .952 | .951 |
| i22 | .908 | .945 | .952 | .952 | .952 |
| i23 | .914 | .952 | .959 | .959 | .958 |
| i24 | .912 | .950 | .957 | .957 | .956 |
| i25 | .911 | .949 | .957 | .957 | .956 |
| i26 | .910 | .948 | .956 | .956 | .955 |
| i27 | .895 | .933 | .942 | .941 | .941 |
| i28 | .899 | .937 | .945 | .945 | .944 |
| i29 | .914 | .952 | .960 | .959 | .959 |
| i30 | .912 | .950 | .958 | .957 | .957 |
| sex2 | -.056 | -.060 | -.061 | -.061 | -.061 |
| race2 | -.037 | -.035 | -.030 | -.031 | -.030 |
| race3 | -.022 | -.021 | -.018 | -.018 | -.018 |
| race4 | -.033 | -.034 | -.033 | -.033 | -.033 |
| race5 | -.027 | -.026 | -.025 | -.025 | -.025 |
| race6 | -.053 | -.054 | -.053 | -.053 | -.053 |

| | | | | | |
|---|---|---|---|---|---|
| regi2 | -.223 | -.232 | -.234 | -.234 | -.234 |
| regi3 | -.243 | -.252 | -.253 | -.253 | -.253 |
| regi4 | -.216 | -.224 | -.225 | -.226 | -.225 |
| | | | | | |
| stoc2 | -.325 | -.338 | -.339 | -.339 | -.339 |
| stoc3 | -.318 | -.332 | -.336 | -.335 | -.335 |
| stoc4 | -.280 | -.292 | -.294 | -.294 | -.294 |
| stoc5 | -.337 | -.351 | -.354 | -.354 | -.354 |
| stoc6 | -.300 | -.312 | -.315 | -.315 | -.315 |
| stoc7 | -.341 | -.355 | -.358 | -.358 | -.357 |
| | | | | | |
| pare2 | -.765 | -.796 | -.803 | -.803 | -.802 |
| pare3 | -.794 | -.827 | -.834 | -.834 | -.834 |
| pare4 | -.771 | -.804 | -.811 | -.811 | -.811 |
| pare5 | -.801 | -.835 | -.843 | -.843 | -.842 |
| pare6 | -.803 | -.837 | -.844 | -.844 | -.844 |

| | i6 | i7 | i8 | i9 | i10 |
|---|---|---|---|---|---|
| i6 | 1.0 | | | | |
| i7 | .960 | 1.0 | | | |
| i8 | .914 | .914 | 1.0 | | |
| i9 | .956 | .956 | .910 | 1.0 | |
| i10 | .957 | .957 | .911 | .964 | 1.0 |
| i11 | .957 | .957 | .911 | .963 | .965 |
| i12 | .956 | .956 | .910 | .962 | .963 |
| i13 | .956 | .956 | .911 | .962 | .963 |
| i14 | .957 | .957 | .911 | .963 | .964 |
| i15 | .957 | .957 | .911 | .963 | .964 |
| i16 | .949 | .950 | .903 | .956 | .957 |
| i17 | .933 | .933 | .890 | .938 | .940 |
| i18 | .946 | .946 | .901 | .952 | .953 |
| i19 | .944 | .944 | .898 | .945 | .946 |
| i20 | .942 | .942 | .896 | .943 | .944 |
| i21 | .950 | .950 | .903 | .952 | .953 |
| i22 | .950 | .950 | .903 | .952 | .953 |
| i23 | .957 | .957 | .911 | .958 | .959 |
| i24 | .955 | .955 | .908 | .956 | .957 |
| i25 | .955 | .955 | .910 | .956 | .957 |
| i26 | .954 | .954 | .908 | .955 | .956 |
| i27 | .940 | .940 | .896 | .940 | .942 |
| i28 | .943 | .943 | .899 | .944 | .945 |
| i29 | .957 | .958 | .911 | .959 | .960 |

| | | | | | |
|---|---|---|---|---|---|
| i30 | .955 | .956 | .909 | .957 | .958 |
| sex2 | -.061 | -.061 | -.059 | -.058 | -.058 |
| race2 | -.029 | -.030 | -.023 | -.032 | -.031 |
| race3 | -.017 | -.018 | -.012 | -.019 | -.019 |
| race4 | -.033 | -.033 | -.031 | -.034 | -.034 |
| race5 | -.025 | -.025 | -.021 | -.024 | -.024 |
| race6 | -.053 | -.053 | -.050 | -.054 | -.054 |
| regi2 | -.233 | -.233 | -.222 | -.234 | -.235 |
| regi3 | -.252 | -.253 | -.239 | -.254 | -.254 |
| regi4 | -.224 | -.225 | -.213 | -.226 | -.226 |
| stoc2 | -.338 | -.338 | -.321 | -.340 | -.340 |
| stoc3 | -.335 | -.335 | -.321 | -.335 | -.336 |
| stoc4 | -.293 | -.293 | -.280 | -.293 | -.294 |
| stoc5 | -.353 | -.353 | -.337 | -.354 | -.354 |
| stoc6 | -.315 | -.314 | -.300 | -.315 | -.316 |
| stoc7 | -.357 | -.357 | -.339 | -.358 | -.358 |
| pare2 | -.801 | -.801 | -.762 | -.801 | -.802 |
| pare3 | -.832 | -.833 | -.792 | -.833 | -.834 |
| pare4 | -.810 | -.810 | -.772 | -.810 | -.812 |
| pare5 | -.841 | -.841 | -.802 | -.842 | -.843 |
| pare6 | -.843 | -.843 | -.802 | -.843 | -.845 |

| | i11 | i12 | i13 | i14 | i15 |
|---|---|---|---|---|---|
| i11 | 1.0 | | | | |
| i12 | .964 | 1.0 | | | |
| i13 | .964 | .962 | 1.0 | | |
| i14 | .964 | .963 | .963 | 1.0 | |
| i15 | .964 | .963 | .963 | .964 | 1.0 |
| i16 | .957 | .956 | .955 | .956 | .956 |
| i17 | .940 | .938 | .939 | .940 | .940 |
| i18 | .953 | .952 | .953 | .953 | .953 |
| i19 | .946 | .945 | .945 | .945 | .945 |
| i20 | .944 | .943 | .944 | .944 | .944 |
| i21 | .953 | .951 | .951 | .952 | .952 |
| i22 | .953 | .952 | .951 | .952 | .952 |
| i23 | .959 | .958 | .958 | .959 | .959 |
| i24 | .957 | .956 | .956 | .957 | .957 |
| i25 | .956 | .956 | .956 | .957 | .957 |

| | | | | | |
|---|---|---|---|---|---|
| i26 | .956 | .955 | .956 | .956 | .956 |
| i27 | .942 | .940 | .941 | .941 | .941 |
| i28 | .945 | .944 | .944 | .945 | .945 |
| i29 | .960 | .959 | .959 | .959 | .959 |
| i30 | .958 | .957 | .957 | .957 | .957 |
| sex2 | -.059 | -.058 | -.059 | -.059 | -.059 |
| race2 | -.030 | -.031 | -.029 | -.029 | -.029 |
| race3 | -.018 | -.019 | -.017 | -.018 | -.018 |
| race4 | -.034 | -.034 | -.034 | -.034 | -.034 |
| race5 | -.024 | -.024 | -.024 | -.024 | -.024 |
| race6 | -.054 | -.054 | -.054 | -.054 | -.054 |
| regi2 | -.234 | -.234 | -.234 | -.234 | -.234 |
| regi3 | -.254 | -.254 | -.253 | -.253 | -.254 |
| regi4 | -.226 | -.226 | -.225 | -.225 | -.225 |
| stoc2 | -.340 | -.340 | -.340 | -.340 | -.340 |
| stoc3 | -.336 | -.336 | -.336 | -.336 | -.336 |
| stoc4 | -.294 | -.293 | -.294 | -.294 | -.294 |
| stoc5 | -.354 | -.354 | -.354 | -.354 | -.355 |
| stoc6 | -.316 | -.315 | -.315 | -.315 | -.316 |
| stoc7 | -.358 | -.358 | -.358 | -.358 | -.358 |
| pare2 | -.803 | -.802 | -.802 | -.802 | -.802 |
| pare3 | -.834 | -.833 | -.833 | -.835 | -.834 |
| pare4 | -.812 | -.810 | -.811 | -.811 | -.811 |
| pare5 | -.843 | -.842 | -.842 | -.843 | -.843 |
| pare6 | -.845 | -.844 | -.844 | -.844 | -.844 |

| | i16 | i17 | i18 | i19 | i20 |
|---|---|---|---|---|---|
| i16 | 1.0 | | | | |
| i17 | .932 | 1.0 | | | |
| i18 | .946 | .931 | 1.0 | | |
| i19 | .938 | .922 | .935 | 1.0 | |
| i20 | .937 | .920 | .933 | .938 | 1.0 |
| i21 | .945 | .927 | .941 | .939 | .937 |
| i22 | .945 | .927 | .941 | .939 | .937 |
| i23 | .952 | .935 | .948 | .946 | .944 |
| i24 | .950 | .932 | .946 | .944 | .942 |
| i25 | .950 | .933 | .947 | .944 | .942 |
| i26 | .948 | .932 | .945 | .942 | .941 |

| | | | | | |
|---|---|---|---|---|---|
| i27 | .934 | .919 | .932 | .928 | .927 |
| i28 | .937 | .922 | .935 | .931 | .930 |
| i29 | .952 | .935 | .949 | .946 | .944 |
| i30 | .950 | .933 | .947 | .944 | .942 |
| | | | | | |
| sex2 | -.058 | -.058 | -.059 | -.060 | -.061 |
| | | | | | |
| race2 | -.030 | -.025 | -.028 | -.031 | -.029 |
| race3 | -.019 | -.015 | -.017 | -.021 | -.020 |
| race4 | -.034 | -.034 | -.035 | -.033 | -.033 |
| race5 | -.024 | -.022 | -.023 | -.025 | -.024 |
| race6 | -.054 | -.053 | -.054 | -.054 | -.054 |
| | | | | | |
| regi2 | -.233 | -.228 | -.231 | -.232 | -.231 |
| regi3 | -.252 | -.246 | -.250 | -.251 | -.250 |
| regi4 | -.224 | -.218 | -.222 | -.222 | -.222 |
| | | | | | |
| stoc2 | -.337 | -.330 | -.335 | -.334 | -.333 |
| stoc3 | -.333 | -.329 | -.333 | -.332 | -.332 |
| stoc4 | -.292 | -.287 | -.291 | -.290 | -.289 |
| stoc5 | -.352 | -.346 | -.351 | -.350 | -.350 |
| stoc6 | -.313 | -.308 | -.312 | -.311 | -.310 |
| stoc7 | -.355 | -.349 | -.354 | -.353 | -.352 |
| | | | | | |
| pare2 | -.796 | -.782 | -.793 | -.791 | -.789 |
| pare3 | -.827 | -.813 | -.825 | -.822 | -.820 |
| pare4 | -.805 | -.792 | -.803 | -.799 | -.798 |
| pare5 | -.836 | -.822 | -.834 | -.830 | -.829 |
| pare6 | -.838 | -.823 | -.835 | -.832 | -.830 |

| | i21 | i22 | i23 | i24 | i25 |
|---|---|---|---|---|---|
| i21 | 1.0 | | | | |
| i22 | .952 | 1.0 | | | |
| i23 | .957 | .957 | 1.0 | | |
| i24 | .956 | .956 | .962 | 1.0 | |
| i25 | .954 | .954 | .962 | .960 | 1.0 |
| i26 | .953 | .953 | .961 | .958 | .959 |
| i27 | .938 | .938 | .946 | .943 | .945 |
| i28 | .938 | .938 | .945 | .942 | .944 |
| i29 | .953 | .953 | .960 | .958 | .958 |
| i30 | .951 | .951 | .958 | .955 | .956 |
| | | | | | |
| sex2 | -.058 | -.058 | -.059 | -.059 | -.060 |

| | | | | | |
|---|---|---|---|---|---|
| race2 | -.035 | -.035 | -.032 | -.033 | -.029 |
| race3 | -.024 | -.023 | -.021 | -.022 | -.019 |
| race4 | -.036 | -.036 | -.035 | -.035 | -.034 |
| race5 | -.024 | -.024 | -.024 | -.024 | -.023 |
| race6 | -.052 | -.052 | -.053 | -.052 | -.052 |
| | | | | | |
| regi2 | -.233 | -.233 | -.235 | -.234 | -.234 |
| regi3 | -.253 | -.253 | -.254 | -.253 | -.253 |
| regi4 | -.224 | -.224 | -.225 | -.225 | -.224 |
| | | | | | |
| stoc2 | -.340 | -.340 | -.341 | -.341 | -.340 |
| stoc3 | -.334 | -.337 | -.337 | -.336 | -.336 |
| stoc4 | -.293 | -.293 | -.295 | -.295 | -.295 |
| stoc5 | -.352 | -.352 | -.355 | -.354 | -.354 |
| stoc6 | -.315 | -.315 | -.317 | -.316 | -.316 |
| stoc7 | -.357 | -.357 | -.359 | -.359 | -.358 |
| | | | | | |
| pare2 | -.796 | -.796 | -.802 | -.800 | -.800 |
| pare3 | -.827 | -.827 | -.833 | -.831 | -.832 |
| pare4 | -.803 | -.804 | -.810 | -.808 | -.810 |
| pare5 | -.835 | -.835 | -.842 | -.840 | -.841 |
| pare6 | -.837 | -.837 | -.843 | -.841 | -.842 |

| | i26 | i27 | i28 | i29 | i30 |
|---|---|---|---|---|---|
| i26 | 1.0 | | | | |
| i27 | .944 | 1.0 | | | |
| i28 | .942 | .929 | 1.0 | | |
| i29 | .956 | .942 | .945 | 1.0 | |
| i30 | .954 | .940 | .943 | .962 | 1.0 |
| | | | | | |
| sex2 | -.060 | -.060 | -.058 | -.058 | -.058 |
| | | | | | |
| race2 | -.029 | -.025 | -.027 | -.032 | -.030 |
| race3 | -.019 | -.016 | -.016 | -.020 | -.019 |
| race4 | -.034 | -.033 | -.033 | -.033 | -.033 |
| race5 | -.023 | -.022 | -.025 | -.026 | -.026 |
| race6 | -.052 | -.051 | -.055 | -.053 | -.052 |
| | | | | | |
| regi2 | -.234 | -.230 | -.231 | -.235 | -.234 |
| regi3 | -.252 | -.248 | -.250 | -.254 | -.253 |
| regi4 | -.224 | -.220 | -.222 | -.226 | -.225 |

| | | | | | |
|---|---|---|---|---|---|
| stoc2 | -.339 | -.334 | -.334 | -.341 | -.339 |
| stoc3 | -.336 | -.332 | -.333 | -.336 | -.336 |
| stoc4 | -.294 | -.290 | -.290 | -.295 | -.294 |
| stoc5 | -.354 | -.349 | -.350 | -.354 | -.354 |
| stoc6 | -.316 | -.311 | -.312 | -.316 | -.315 |
| stoc7 | -.358 | -.352 | -.353 | -.358 | -.358 |
| | | | | | |
| pare2 | -.799 | -.787 | -.790 | -.802 | -.801 |
| pare3 | -.831 | -.818 | -.821 | -.834 | -.833 |
| pare4 | -.808 | -.797 | -.800 | -.811 | -.809 |
| pare5 | -.840 | -.828 | -.831 | -.843 | -.841 |
| pare6 | -.841 | -.828 | -.831 | -.844 | -.842 |

| | sex2 | race2 | race3 | race4 | race5 |
|---|---|---|---|---|---|
| sex2 | 1.0 | | | | |
| | | | | | |
| race2 | -.015 | 1.0 | | | |
| race3 | .041 | .266 | 1.0 | | |
| race4 | .015 | .106 | .115 | 1.0 | |
| race5 | .022 | .122 | .121 | .043 | 1.0 |
| race6 | .012 | .012 | .018 | .010 | .007 |
| | | | | | |
| regi2 | .001 | -.127 | -.020 | -.027 | -.003 |
| regi3 | .009 | -.008 | .010 | -.011 | .021 |
| regi4 | .005 | .021 | -.103 | -.047 | -.026 |
| | | | | | |
| stoc2 | -.003 | -.197 | -.107 | -.055 | -.031 |
| stoc3 | .016 | -.050 | -.001 | -.008 | .003 |
| stoc4 | .011 | -.120 | -.062 | -.034 | -.008 |
| stoc5 | .015 | -.037 | -.015 | -.006 | .014 |
| stoc6 | .009 | -.076 | -.030 | -.003 | .003 |
| stoc7 | .004 | -.041 | -.019 | -.003 | .007 |
| | | | | | |
| pare2 | -.013 | .034 | -.005 | .035 | .014 |
| pare3 | -.008 | .031 | -.005 | .038 | .006 |
| pare4 | -.006 | .030 | -.003 | .031 | .007 |
| pare5 | -.006 | .028 | .001 | .035 | .004 |
| pare6 | -.017 | .036 | -.002 | .037 | .006 |

| | race6 | regi2 | regi3 | regi4 | stoc2 |
|---|---|---|---|---|---|
| race6 | 1.0 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| regi2 | .002 | 1.0 | | | |
| regi3 | -.004 | .554 | 1.0 | | |
| regi4 | -.003 | .568 | .575 | 1.0 | |
| | | | | | |
| stoc2 | -.005 | .205 | .231 | .105 | 1.0 |
| stoc3 | -.001 | .106 | .192 | .040 | .603 |
| stoc4 | -.008 | .054 | .126 | -.058 | .637 |
| stoc5 | -.001 | .184 | .242 | .097 | .619 |
| stoc6 | -.008 | -.017 | .147 | .017 | .650 |
| stoc7 | -.006 | .053 | .218 | .050 | .688 |
| | | | | | |
| pare2 | .060 | .011 | -.019 | .019 | -.017 |
| pare3 | .059 | .019 | -.026 | .018 | -.011 |
| pare4 | .060 | .018 | -.020 | .020 | -.012 |
| pare5 | .063 | .025 | -.019 | .025 | -.013 |
| pare6 | .062 | .020 | -.022 | .018 | -.017 |

| | stoc3 | stoc4 | stoc5 | stoc6 | stoc7 |
|---|---|---|---|---|---|
| stoc3 | 1.0 | | | | |
| stoc4 | .628 | 1.0 | | | |
| stoc5 | .612 | .631 | 1.0 | | |
| stoc6 | .656 | .690 | .655 | 1.0 | |
| stoc7 | .690 | .720 | .697 | .764 | 1.0 |
| | | | | | |
| pare2 | -.000 | -.040 | -.006 | -.039 | -.032 |
| pare3 | .000 | -.040 | -.005 | -.043 | -.034 |
| pare4 | -.001 | -.037 | -.007 | -.041 | -.028 |
| pare5 | -.015 | -.047 | -.012 | -.050 | -.037 |
| pare6 | -.009 | -.049 | -.012 | -.048 | -.038 |

| | pare2 | pare3 | pare4 | pare5 | pare6 |
|---|---|---|---|---|---|
| pared2 | 1.0 | | | | |
| pared3 | .923 | 1.0 | | | |
| pared4 | .897 | .931 | 1.0 | | |
| pared5 | .933 | .969 | .942 | 1.0 | |
| pared6 | .937 | .973 | .945 | .984 | 1.0 |

# 18 Appendix 5 – parameter correlation matrix for 4-level 2PL model

Item intercepts

| | i1 | i2 | i3 | i4 | i5 |
|---|---|---|---|---|---|
| i 1 | 1.0 | | | | |
| i 2 | .778 | 1.0 | | | |
| i 3 | .799 | .926 | 1.0 | | |
| i 4 | .799 | .928 | .959 | 1.0 | |
| i 5 | .799 | .927 | .958 | .961 | 1.0 |
| i 6 | .797 | .925 | .955 | .957 | .957 |
| i 7 | .797 | .925 | .956 | .958 | .957 |
| i 8 | .652 | .757 | .776 | .779 | .779 |
| i 9 | .795 | .922 | .953 | .956 | .957 |
| i10 | .796 | .924 | .954 | .958 | .958 |
| i11 | .796 | .923 | .954 | .958 | .958 |
| i12 | .772 | .896 | .925 | .928 | .928 |
| i13 | .751 | .871 | .899 | .902 | .902 |
| i14 | .772 | .894 | .924 | .926 | .926 |
| i15 | .797 | .925 | .956 | .960 | .960 |
| i16 | .786 | .913 | .943 | .946 | .947 |
| i17 | .747 | .867 | .895 | .899 | .899 |
| i18 | .783 | .909 | .940 | .943 | .943 |
| i19 | .775 | .900 | .929 | .933 | .933 |
| i20 | .777 | .903 | .933 | .936 | .936 |
| i21 | .689 | .797 | .825 | .827 | .827 |
| i22 | .690 | .801 | .831 | .833 | .833 |
| i23 | .789 | .916 | .946 | .950 | .950 |
| i24 | .789 | .916 | .946 | .905 | .950 |
| i25 | .793 | .920 | .951 | .955 | .955 |
| i26 | .791 | .918 | .948 | .952 | .952 |
| i27 | .783 | .909 | .940 | .943 | .943 |
| i28 | .785 | .911 | .942 | .946 | .946 |
| i29 | .797 | .925 | .956 | .959 | .960 |
| i30 | .795 | .922 | .953 | .957 | .957 |
| sex2 | -.057 | -.068 | -.060 | -.062 | -.063 |
| race2 | -.031 | -.035 | -.029 | -.030 | -.030 |
| race3 | -.021 | -.022 | -.018 | -.018 | -.018 |

| | | | | | |
|---|---|---|---|---|---|
| race4 | -.032 | -.032 | -.034 | -.035 | -.035 |
| race5 | -.023 | -.020 | -.023 | -.024 | -.024 |
| race6 | -.046 | -.047 | -.051 | -.051 | -.051 |
| | | | | | |
| regi2 | -.195 | -.217 | -.222 | -.223 | -.223 |
| regi3 | -.214 | -.249 | -.250 | -.251 | -.251 |
| regi4 | -.186 | -.210 | -.212 | -.213 | -.213 |
| | | | | | |
| stoc2 | -.297 | -.342 | -.353 | -.355 | -.355 |
| stoc3 | -.290 | -.341 | -.355 | -.356 | -.356 |
| stoc4 | -.261 | -.303 | -.314 | -.316 | -.315 |
| stoc5 | -.275 | -.324 | -.335 | -.336 | -.336 |
| stoc6 | -.265 | -.310 | -.320 | -.322 | -.322 |
| stoc7 | -.304 | -.355 | -.366 | -.368 | -.368 |
| | | | | | |
| pare2 | -.654 | -.760 | -.788 | -.791 | -.791 |
| pare3 | -.679 | -.788 | -.818 | -.821 | -.821 |
| pare4 | -.657 | -.765 | -.796 | -.799 | -.799 |
| pare5 | -.684 | -.794 | -.824 | -.827 | -.827 |
| pare6 | -.687 | -.797 | -.826 | -.829 | -.829 |

| | i6 | i7 | i8 | i9 | i10 |
|---|---|---|---|---|---|
| i6 | 1.0 | | | | |
| i7 | .954 | 1.0 | | | |
| i8 | .776 | .778 | 1.0 | | |
| i9 | .952 | .952 | .774 | 1.0 | |
| i10 | .954 | .954 | .775 | .960 | 1.0 |
| i11 | .953 | .953 | .775 | .960 | .962 |
| i12 | .924 | .924 | .751 | .934 | .936 |
| i13 | .898 | .898 | .728 | .911 | .913 |
| i14 | .923 | .923 | .750 | .934 | .936 |
| i15 | .956 | .955 | .777 | .961 | .967 |
| i16 | .942 | .942 | .766 | .949 | .951 |
| i17 | .895 | .895 | .728 | .901 | .903 |
| i18 | .939 | .939 | .762 | .945 | .947 |
| i19 | .929 | .929 | .758 | .932 | .933 |
| i20 | .932 | .932 | .759 | .935 | .937 |
| i21 | .824 | .824 | .670 | .827 | .828 |
| i22 | .830 | .830 | .674 | .833 | .835 |
| i23 | .946 | .946 | .769 | .949 | .951 |
| i24 | .946 | .946 | .769 | .949 | .951 |
| i25 | .950 | .950 | .773 | .954 | .956 |
| i26 | .948 | .948 | .770 | .951 | .953 |

| | | | | | |
|---|---|---|---|---|---|
| i27 | .939 | .939 | .763 | .942 | .944 |
| i28 | .942 | .941 | .766 | .945 | .947 |
| i29 | .955 | .955 | .776 | .959 | .960 |
| i30 | .953 | .953 | .774 | .956 | .958 |
| | | | | | |
| sex2 | -.065 | -.063 | -.045 | -.059 | -.060 |
| | | | | | |
| race2 | -.029 | -.030 | -.013 | -.033 | -.031 |
| race3 | -.017 | -.018 | -.012 | -.021 | -.020 |
| race4 | -.035 | -.035 | -.024 | -.037 | -.037 |
| race5 | -.023 | -.023 | -.016 | -.026 | -.024 |
| race6 | -.051 | -.051 | -.040 | -.050 | -.051 |
| | | | | | |
| regi2 | -.222 | -.222 | -.181 | -.224 | -.224 |
| regi3 | -.250 | -.250 | -.212 | -.253 | -.252 |
| regi4 | -.212 | -.212 | -.177 | -.214 | -.214 |
| | | | | | |
| stoc2 | -.353 | -.353 | -.289 | -.356 | -.356 |
| stoc3 | -.354 | -.354 | -.291 | -.354 | -.356 |
| stoc4 | -.314 | -.314 | -.258 | -.315 | -.315 |
| stoc5 | -.334 | -.334 | -.272 | -.336 | -.337 |
| stoc6 | -.320 | -.320 | -.263 | -.321 | -.322 |
| stoc7 | -.365 | -.365 | -.300 | -.368 | -.368 |
| | | | | | |
| pare2 | -.788 | -.788 | -.639 | -.790 | -.791 |
| pare3 | -.818 | -.817 | -.662 | -.820 | -.821 |
| pare4 | -.795 | -.795 | -.645 | -.798 | -.799 |
| pare5 | -.824 | -.823 | -.667 | -.826 | -.827 |
| pare6 | -.825 | -.825 | -.669 | -.828 | -.830 |

| | i11 | i12 | i13 | i14 | i15 |
|---|---|---|---|---|---|
| i11 | 1.0 | | | | |
| i12 | .937 | 1.0 | | | |
| i13 | .913 | .899 | 1.0 | | |
| i14 | .937 | .923 | .911 | 1.0 | |
| i15 | .962 | .934 | .909 | .933 | 1.0 |
| i16 | .951 | .927 | .906 | .928 | .951 |
| i17 | .903 | .883 | .856 | .879 | .903 |
| i18 | .947 | .923 | .898 | .921 | .948 |
| i19 | .933 | .905 | .880 | .904 | .935 |
| i20 | .937 | .908 | .883 | .907 | .939 |
| i21 | .828 | .807 | .787 | .808 | .829 |
| i22 | .834 | .812 | .792 | .813 | .835 |

| | | | | | |
|---|---|---|---|---|---|
| i23 | .950 | .923 | .897 | .921 | .952 |
| i24 | .950 | .921 | .896 | .920 | .952 |
| i25 | .955 | .926 | .900 | .924 | .957 |
| i26 | .953 | .924 | .898 | .922 | .955 |
| i27 | .944 | .913 | .887 | .911 | .946 |
| i28 | .946 | .916 | .889 | .914 | .949 |
| i29 | .960 | .929 | .904 | .928 | .962 |
| i30 | .957 | .927 | .902 | .926 | .959 |
| sex2 | -.060 | -.067 | -.047 | -.052 | -.060 |
| race2 | -.030 | -.024 | -.042 | -.035 | -.028 |
| race3 | -.019 | -.013 | -.025 | -.026 | -.018 |
| race4 | -.037 | -.036 | -.041 | -.038 | -.037 |
| race5 | -.023 | -.018 | -.030 | -.024 | -.023 |
| race6 | -.051 | -.050 | -.049 | -.050 | -.052 |
| regi2 | -.224 | -.214 | -.214 | -.219 | -.224 |
| regi3 | -.252 | -.246 | -.243 | -.247 | -.252 |
| regi4 | -.214 | -.206 | -.207 | -.211 | -.214 |
| stoc2 | -.356 | -.341 | -.345 | -.346 | -.356 |
| stoc3 | -.355 | -.347 | -.333 | -.343 | -.356 |
| stoc4 | -.315 | -.306 | -.301 | -.304 | -.315 |
| stoc5 | -.337 | -.328 | -.320 | -.325 | -.337 |
| stoc6 | -.322 | -.315 | -.309 | -.313 | -.323 |
| stoc7 | -.367 | -.358 | -.352 | -.358 | -.369 |
| pare2 | -.791 | -.765 | -.739 | -.762 | -.793 |
| pare3 | -.821 | -.792 | -.767 | -.790 | -.824 |
| pare4 | -.799 | -.773 | -.744 | -.768 | -.802 |
| pare5 | -.827 | -.798 | -.770 | -.795 | -.830 |
| pare6 | -.829 | -.801 | -.774 | -.798 | -.832 |

| | i16 | i17 | i18 | i19 | i20 |
|---|---|---|---|---|---|
| i16 | 1.0 | | | | |
| i17 | .892 | 1.0 | | | |
| i18 | .937 | .891 | 1.0 | | |
| i19 | .922 | .876 | .919 | 1.0 | |
| i20 | .926 | .879 | .922 | .920 | 1.0 |
| i21 | .819 | .777 | .815 | .807 | .811 |
| i22 | .824 | .783 | .821 | .812 | .817 |
| i23 | .940 | .892 | .936 | .926 | .929 |

| | | | | | |
|---|---|---|---|---|---|
| i24 | .939 | .892 | .936 | .926 | .929 |
| i25 | .944 | .897 | .941 | .930 | .934 |
| i26 | .942 | .894 | .938 | .928 | .931 |
| i27 | .933 | .885 | .929 | .918 | .922 |
| i28 | .935 | .888 | .932 | .921 | .925 |
| i29 | .949 | .900 | .945 | .934 | .938 |
| i30 | .946 | .898 | .942 | .931 | .935 |
| sex2 | -.059 | -.065 | -.064 | -.062 | -.061 |
| race2 | -.032 | -.019 | -.028 | -.033 | -.029 |
| race3 | -.020 | -.013 | -.017 | -.018 | -.020 |
| race4 | -.037 | -.030 | -.036 | -.036 | -.034 |
| race5 | -.024 | -.017 | -.022 | -.020 | -.022 |
| race6 | -.052 | -.044 | -.053 | -.052 | -.052 |
| regi2 | -.220 | -.209 | -.220 | -.216 | -.218 |
| regi3 | -.250 | -.237 | -.247 | -.245 | -.245 |
| regi4 | -.211 | -.198 | -.209 | -.208 | -.208 |
| stoc2 | -.351 | -.333 | -.349 | -.343 | -.346 |
| stoc3 | -.351 | -.332 | -.351 | -.345 | -.348 |
| stoc4 | -.311 | -.295 | -.311 | -.304 | -.307 |
| stoc5 | -.333 | -.316 | -.332 | -.326 | -.330 |
| stoc6 | -.319 | -.298 | -.317 | -.313 | -.315 |
| stoc7 | -.364 | -.344 | -.362 | -.357 | -.359 |
| pare2 | -.781 | -.743 | -.779 | -.770 | -.773 |
| pare3 | -.811 | -.772 | -.808 | -.800 | -.802 |
| pare4 | -.788 | -.751 | -.787 | -.778 | -.780 |
| pare5 | -.816 | -.778 | -.815 | -.806 | -.808 |
| pare6 | -.819 | -.779 | -.816 | -.808 | -.810 |

| | i21 | i22 | i23 | i24 | i25 |
|---|---|---|---|---|---|
| i21 | 1.0 | | | | |
| i22 | .780 | 1.0 | | | |
| i23 | .836 | .844 | 1.0 | | |
| i24 | .829 | .836 | .950 | 1.0 | |
| i25 | .835 | .841 | .953 | .951 | 1.0 |
| i26 | .836 | .841 | .952 | .949 | .954 |
| i27 | .815 | .822 | .936 | .936 | .942 |
| i28 | .817 | .824 | .938 | .938 | .943 |
| i29 | .829 | .835 | .952 | .952 | .957 |

| | | | | | |
|---|---|---|---|---|---|
| i30 | .827 | .833 | .949 | .949 | .954 |
| sex2 | -.056 | -.060 | -.062 | -.060 | -.061 |
| race2 | -.026 | -.017 | -.029 | -.032 | -.028 |
| race3 | -.024 | -.018 | -.020 | -.021 | -.019 |
| race4 | -.041 | -.030 | -.035 | -.035 | -.036 |
| race5 | -.025 | -.023 | -.023 | -.024 | -.022 |
| race6 | -.044 | -.045 | -.050 | -.049 | -.050 |
| regi2 | -.202 | -.207 | -.221 | -.220 | -.223 |
| regi3 | -.216 | -.212 | -.249 | -.250 | -.250 |
| regi4 | -.190 | -.192 | -.212 | -.213 | -.213 |
| stoc2 | -.299 | -.301 | -.352 | -.354 | -.355 |
| stoc3 | -.299 | -.304 | -.354 | -.353 | -.357 |
| stoc4 | -.265 | -.270 | -.315 | -.315 | -.317 |
| stoc5 | -.278 | -.277 | -.334 | -.335 | -.336 |
| stoc6 | -.270 | -.274 | -.320 | -.321 | -.322 |
| stoc7 | -.309 | -.310 | -.365 | -.366 | -.368 |
| pare2 | -.684 | -.688 | -.784 | -.784 | -.788 |
| pare3 | -.708 | -.717 | -.814 | -.814 | -.818 |
| pare4 | -.691 | -.698 | -.792 | -.791 | -.796 |
| pare5 | -.718 | -.725 | -.820 | -.820 | -.824 |
| pare6 | -.718 | -.722 | -.822 | -.822 | -.826 |

| | i26 | i27 | i28 | i29 | i30 |
|---|---|---|---|---|---|
| i26 | 1.0 | | | | |
| i27 | .939 | 1.0 | | | |
| i28 | .941 | .933 | 1.0 | | |
| i29 | .954 | .946 | .948 | 1.0 | |
| i30 | .952 | .943 | .945 | .961 | 1.0 |
| sex2 | -.063 | -.062 | -.058 | -.060 | -.060 |
| race2 | -.027 | -.022 | -.025 | -.034 | -.031 |
| race3 | -.018 | -.014 | -.014 | -.021 | -.020 |
| race4 | -.035 | -.034 | -.034 | -.036 | -.036 |
| race5 | -.022 | -.020 | -.023 | -.026 | -.025 |
| race6 | -.050 | -.049 | -.053 | -.050 | -.050 |
| regi2 | -.222 | -.220 | -.221 | -.224 | -.223 |

| | | | | | |
|---|---|---|---|---|---|
| regi3 | -.250 | -.247 | -.249 | -.252 | -.251 |
| regi4 | -.212 | -.208 | -.211 | -.214 | -.213 |
| stoc2 | -.355 | -.351 | -.350 | -.357 | -.356 |
| stoc3 | -.355 | -.355 | -.354 | -.356 | -.356 |
| stoc4 | -.316 | -.314 | -.312 | -.317 | -.316 |
| stoc5 | -.335 | -.334 | -.333 | -.337 | -.337 |
| stoc6 | -.321 | -.319 | -.318 | -.322 | -.322 |
| stoc7 | -.367 | -.364 | -.364 | -.369 | -.368 |
| pare2 | -.785 | -.779 | -.782 | -.793 | -.790 |
| pare3 | -.816 | -.810 | -.812 | -.823 | -.821 |
| pare4 | -.794 | -.788 | -.791 | -.800 | -.798 |
| pare5 | -.822 | -.816 | -.819 | -.829 | -.826 |
| pare6 | -.824 | -.817 | -.819 | -.831 | -.828 |

| | sex2 | race2 | race3 | race4 | race5 |
|---|---|---|---|---|---|
| sex2 | 1.0 | | | | |
| race2 | -.010 | 1.0 | | | |
| race3 | .029 | .259 | 1.0 | | |
| race4 | .017 | .100 | .113 | 1.0 | |
| race5 | .020 | .119 | .126 | .042 | 1.0 |
| race6 | .012 | .013 | .012 | .009 | .005 |
| regi2 | -.003 | -.080 | -.013 | -.009 | -.001 |
| regi3 | -.002 | .001 | .014 | -.000 | .009 |
| regi4 | .009 | .023 | -.069 | -.026 | -.032 |
| stoc2 | .000 | -.139 | -.108 | -.034 | -.017 |
| stoc3 | .003 | -.088 | -.021 | -.008 | .014 |
| stoc4 | .013 | -.080 | -.053 | -.027 | .008 |
| stoc5 | .011 | -.040 | -.008 | -.006 | .023 |
| stoc6 | .005 | -.072 | -.038 | -.002 | .015 |
| stoc7 | -.002 | -.033 | -.017 | -.003 | .022 |
| pare2 | -.005 | .034 | .004 | .032 | .006 |
| pare3 | -.000 | .027 | -.001 | .034 | -.003 |
| pare4 | .003 | .025 | .003 | .027 | -.001 |
| pare5 | .001 | .026 | .005 | .032 | -.004 |
| pare6 | -.008 | .032 | .005 | .034 | -.001 |

| | race6 | regi2 | regi3 | regi4 | stoc2 |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| race6 | 1.0 | | | | |
| regi2 | -.001 | 1.0 | | | |
| regi3 | -.008 | .497 | 1.0 | | |
| regi4 | -.007 | .543 | .500 | 1.0 | |
| stoc2 | -.005 | .132 | .219 | .060 | 1.0 |
| stoc3 | -.009 | .098 | .243 | .013 | .680 |
| stoc4 | -.007 | .064 | .175 | -.007 | .677 |
| stoc5 | -.004 | .100 | .241 | .009 | .646 |
| stoc6 | -.007 | -.049 | .200 | .013 | .658 |
| stoc7 | -.006 | .018 | .245 | .044 | .713 |
| pare2 | .059 | .003 | -.039 | .008 | -.017 |
| pare3 | .058 | .013 | -.047 | .008 | -.005 |
| pare4 | .060 | .009 | -.042 | .006 | -.012 |
| pare5 | .062 | .016 | -.043 | .011 | -.010 |
| pare6 | .061 | .010 | -.045 | .003 | -.015 |

| | stoc3 | stoc4 | stoc5 | stoc6 | stoc7 |
|---|---|---|---|---|---|
| stoc3 | 1.0 | | | | |
| stoc4 | .665 | 1.0 | | | |
| stoc5 | .687 | .624 | 1.0 | | |
| stoc6 | .701 | .650 | .678 | 1.0 | |
| stoc7 | .730 | .701 | .707 | .783 | 1.0 |
| pare2 | -.022 | -.030 | -.034 | -.059 | -.045 |
| pare3 | -.020 | -.029 | -.034 | -.061 | -.044 |
| pare4 | -.021 | -.027 | -.037 | -.058 | -.041 |
| pare5 | -.038 | -.038 | -.045 | -.070 | -.050 |
| pare6 | -.031 | -.040 | -.043 | -.066 | -.049 |

| | pare2 | pare3 | pare4 | pare5 | pare6 |
|---|---|---|---|---|---|
| pare2 | 1.0 | | | | |
| pare3 | .928 | 1.0 | | | |
| pare4 | .904 | .935 | 1.0 | | |
| pare5 | .937 | .972 | .945 | 1.0 | |
| pare6 | .941 | .975 | .948 | .985 | 1.0 |

Item slopes

| | i1 | i2 | i3 | i4 | i5 |
|---|---|---|---|---|---|
| s2 | -.389 | .113 | -.010 | -.009 | -.009 |
| s3 | -.393 | -.005 | -.027 | -.003 | -.003 |
| s4 | -.384 | -.014 | .001 | .007 | -.001 |
| s5 | -.383 | -.022 | -.010 | -.010 | -.012 |
| s6 | -.390 | -.021 | -.006 | -.006 | -.007 |
| s7 | -.392 | -.016 | -.004 | -.003 | -.003 |
| s8 | -.329 | -.027 | -.014 | -.015 | -.015 |
| s9 | -.383 | -.012 | -.007 | -.005 | -.006 |
| s10 | -.391 | -.008 | -.003 | -.001 | -.002 |
| s11 | -.397 | -.009 | -.004 | -.002 | -.003 |
| s12 | -.411 | -.007 | .000 | .001 | .001 |
| s13 | -.407 | -.019 | -.012 | -.010 | -.011 |
| s14 | -.419 | -.016 | -.009 | -.007 | -.007 |
| s15 | -.322 | -.006 | -.001 | .001 | .001 |
| s16 | -.378 | .000 | .006 | .008 | .007 |
| s17 | -.355 | -.011 | -.003 | -.002 | -.002 |
| s18 | -.372 | -.014 | -.008 | -.006 | -.007 |
| s19 | -.350 | -.003 | .000 | .002 | .001 |
| s20 | -.349 | -.012 | -.006 | -.005 | -.005 |
| s21 | -.377 | .001 | .010 | .011 | .010 |
| s22 | -.373 | .010 | .021 | .022 | .022 |
| s23 | -.412 | -.013 | -.007 | -.005 | -.005 |
| s24 | -.398 | -.012 | -.006 | -.004 | -.004 |
| s25 | -.389 | -.019 | -.012 | -.011 | -.011 |
| s26 | -.393 | -.017 | -.011 | -.010 | -.010 |
| s27 | -.070 | .010 | .012 | .013 | .013 |
| s28 | -.166 | -.012 | -.010 | -.009 | -.010 |
| s29 | -.301 | -.015 | -.009 | -.009 | -.009 |
| s30 | -.322 | -.015 | -.010 | -.007 | -.008 |

| | i6 | i7 | i8 | i9 | i10 |
|---|---|---|---|---|---|
| s2 | -.008 | -.009 | -.001 | -.008 | -.008 |
| s3 | -.002 | -.004 | .013 | -.002 | -.003 |
| s4 | -.005 | -.002 | .006 | -.001 | -.000 |
| s5 | -.013 | -.012 | .003 | -.011 | -.011 |
| s6 | -.038 | -.007 | -.007 | -.006 | -.006 |
| s7 | -.003 | -.004 | -.039 | -.003 | -.003 |
| s8 | -.015 | -.016 | -.393 | -.015 | -.015 |

| | | | | | |
|---|---|---|---|---|---|
| s9 | -.007 | -.006 | -.012 | .020 | -.005 |
| s10 | -.003 | -.002 | -.010 | -.000 | .007 |
| s11 | -.004 | -.003 | -.011 | -.002 | -.002 |
| s12 | -.000 | .001 | -.006 | -.002 | -.001 |
| s13 | -.012 | -.012 | -.012 | -.015 | -.014 |
| s14 | -.009 | -.008 | -.013 | -.010 | -.009 |
| s15 | -.001 | .000 | -.008 | .002 | .001 |
| s16 | .006 | .007 | -.000 | .008 | .008 |
| s17 | -.003 | -.003 | -.011 | -.001 | -.001 |
| s18 | -.008 | -.007 | -.007 | -.005 | -.006 |
| s19 | .000 | .001 | .008 | .001 | .001 |
| s20 | -.007 | -.005 | -.007 | -.004 | -.004 |
| s21 | .009 | .010 | .001 | .011 | .011 |
| s22 | .020 | .021 | .010 | .022 | .022 |
| s23 | -.007 | -.006 | -.013 | -.005 | -.005 |
| s24 | -.006 | -.005 | -.010 | -.004 | -.004 |
| s25 | -.013 | -.012 | -.019 | -.011 | -.011 |
| s26 | -.012 | -.011 | -.017 | -.010 | -.010 |
| s27 | .012 | .012 | .005 | .013 | .013 |
| s28 | -.010 | -.010 | -.017 | -.009 | -.009 |
| s29 | -.011 | -.010 | -.017 | -.009 | -.009 |
| s30 | -.008 | -.009 | -.017 | -.005 | -.006 |

| | i11 | i12 | i13 | i14 | i15 |
|---|---|---|---|---|---|
| s2 | -.008 | -.007 | -.007 | -.009 | -.008 |
| s3 | -.003 | -.004 | -.002 | -.005 | -.002 |
| s4 | -.000 | -.001 | -.004 | -.002 | .000 |
| s5 | -.011 | -.011 | -.013 | -.013 | -.010 |
| s6 | -.006 | -.005 | -.007 | -.008 | -.006 |
| s7 | -.003 | -.004 | -.002 | -.004 | -.003 |
| s8 | -.015 | -.014 | -.012 | -.015 | -.014 |
| s9 | -.006 | -.014 | .004 | -.002 | -.005 |
| s10 | -.001 | -.004 | .009 | .000 | -.001 |
| s11 | -.002 | -.009 | .008 | .000 | -.002 |
| s12 | -.006 | .066 | -.022 | -.011 | .001 |
| s13 | -.014 | -.009 | -.149 | -.031 | -.011 |
| s14 | -.009 | -.008 | -.026 | -.080 | -.007 |
| s15 | .001 | -.005 | .010 | .004 | -.008 |
| s16 | .008 | .003 | .020 | .013 | .008 |
| s17 | -.001 | -.010 | .005 | -.001 | -.001 |
| s18 | -.006 | -.012 | .001 | -.004 | -.005 |
| s19 | .001 | .001 | .002 | .001 | .001 |
| s20 | -.004 | -.004 | -.003 | -.003 | -.004 |

| | | | | | |
|---|---|---|---|---|---|
| s21 | .011 | .010 | .014 | .012 | .011 |
| s22 | .022 | .020 | .024 | .022 | .022 |
| s23 | -.005 | -.007 | -.009 | -.010 | -.004 |
| s24 | -.004 | -.005 | -.005 | -.006 | -.003 |
| s25 | -.011 | -.014 | -.010 | -.014 | -.010 |
| s26 | -.010 | -.011 | -.010 | -.013 | -.009 |
| s27 | .013 | .012 | .014 | .013 | .013 |
| s28 | -.009 | -.009 | -.003 | -.006 | -.010 |
| s29 | -.009 | -.010 | -.002 | -.009 | -.009 |
| s30 | -.006 | -.009 | -.001 | -.003 | -.006 |

| | i16 | i17 | i18 | i19 | i20 |
|---|---|---|---|---|---|
| s2 | -.007 | -.006 | -.008 | -.006 | -.007 |
| s3 | -.002 | -.002 | -.002 | -.000 | -.002 |
| s4 | -.000 | -.001 | .000 | .000 | .000 |
| s5 | -.011 | -.009 | -.011 | -.010 | -.010 |
| s6 | -.006 | -.006 | -.005 | -.007 | -.005 |
| s7 | -.002 | -.004 | -.002 | -.002 | -.001 |
| s8 | -.014 | -.015 | -.013 | -.018 | -.015 |
| s9 | -.005 | -.008 | -.006 | -.004 | -.004 |
| s10 | .000 | -.004 | -.001 | .000 | .000 |
| s11 | -.002 | -.005 | -.002 | -.001 | -.001 |
| s12 | -.003 | .007 | .003 | .001 | .002 |
| s13 | -.018 | -.006 | -.011 | -.010 | -.010 |
| s14 | -.012 | -.002 | -.006 | -.007 | -.007 |
| s15 | .002 | -.002 | .001 | .003 | .002 |
| s16 | .044 | -.007 | .006 | .009 | .008 |
| s17 | .003 | -.168 | -.002 | -.001 | -.000 |
| s18 | -.003 | -.011 | -.056 | -.005 | -.005 |
| s19 | .002 | .003 | .002 | .079 | -.002 |
| s20 | -.004 | -.003 | -.004 | -.000 | .031 |
| s21 | .011 | .009 | .011 | .012 | .013 |
| s22 | .022 | .019 | .022 | .022 | .024 |
| s23 | - .005 | -.006 | -.004 | -.004 | -.003 |
| s24 | -.004 | -.005 | -.003 | -.002 | -.003 |
| s25 | -.010 | -.012 | -.010 | -.010 | -.010 |
| s26 | -.009 | -.011 | -.009 | -.007 | -.008 |
| s27 | .013 | .012 | .013 | .012 | .013 |
| s28 | -.009 | -.009 | -.010 | -.010 | -.010 |
| s29 | -.009 | -.012 | -.009 | -.010 | -.009 |
| s30 | -.005 | -.008 | -.006 | -.007 | -.006 |

| | i21 | i22 | i23 | i24 | i25 |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| s2 | -.014 | -.009 | -.008 | -.008 | -.008 |
| s3 | -.013 | -.004 | -.003 | -.002 | -.003 |
| s4 | -.002 | .005 | .000 | .000 | .000 |
| s5 | -.015 | -.008 | -.011 | -.010 | -.011 |
| s6 | -.011 | -.003 | -.006 | -.006 | -.006 |
| s7 | -.005 | .001 | -.003 | -.003 | -.003 |
| s8 | -.016 | -.010 | -.014 | -.015 | -.015 |
| s9 | -.009 | -.002 | -.005 | -.004 | -.005 |
| s10 | -.007 | -.001 | -.002 | -.001 | -.001 |
| s11 | -.007 | -.001 | -.002 | -.002 | -.003 |
| s12 | -.003 | .004 | .002 | .001 | .002 |
| s13 | -.019 | -.012 | -.011 | -.011 | -.010 |
| s14 | -.019 | -.008 | -.008 | -.008 | -.007 |
| s15 | -.002 | .001 | .001 | .001 | .001 |
| s16 | .002 | .010 | .007 | .007 | .008 |
| s17 | -.004 | .002 | -.002 | -.002 | -.002 |
| s18 | -.008 | -.001 | -.006 | -.006 | -.006 |
| s19 | -.010 | -.006 | .001 | .002 | .001 |
| s20 | -.014 | -.007 | -.005 | -.004 | -.005 |
| s21 | .264 | .059 | .012 | .009 | .014 |
| s22 | .063 | .267 | .025 | .021 | .026 |
| s23 | -.023 | -.009 | .024 | -.002 | -.003 |
| s24 | -.023 | -.017 | -.001 | .047 | -.003 |
| s25 | -.030 | -.020 | -.010 | -.009 | -.036 |
| s26 | -.038 | -.026 | -.010 | -.007 | -.011 |
| s27 | .004 | .014 | .012 | .013 | .013 |
| s28 | -.017 | -.017 | -.013 | -.011 | -.012 |
| s29 | -.015 | -.009 | -.009 | -.009 | -.011 |
| s30 | -.021 | -.015 | -.008 | -.007 | -.008 |

| | i26 | i27 | i28 | i29 | i30 |
|---|---|---|---|---|---|
| s2 | -.008 | -.008 | -.008 | -.008 | -.009 |
| s3 | -.003 | -.002 | -.002 | -.002 | -.003 |
| s4 | .000 | .001 | .001 | .000 | -.000 |
| s5 | -.011 | -.010 | -.009 | -.011 | -.011 |
| s6 | -.006 | -.005 | -.005 | -.006 | -.007 |
| s7 | -.003 | -.002 | -.002 | -.002 | -.003 |
| s8 | -.014 | -.014 | -.015 | -.014 | -.014 |
| s9 | -.005 | -.005 | -.005 | -.004 | -.005 |
| s10 | -.001 | .000 | -.000 | -.000 | -.001 |
| s11 | -.003 | -.002 | -.002 | -.002 | -.003 |
| s12 | .002 | .004 | .004 | .001 | .001 |

| | | | | | |
|---|---|---|---|---|---|
| s13 | -.010 | -.008 | -.008 | -.011 | -.011 |
| s14 | -.008 | -.005 | -.004 | -.007 | -.007 |
| s15 | .001 | .002 | .002 | .002 | .001 |
| s16 | .007 | .009 | .009 | .008 | .008 |
| s17 | -.002 | .001 | .001 | -.000 | -.001 |
| s18 | -.006 | -.004 | -.005 | -.005 | -.006 |
| s19 | .000 | .002 | .002 | .001 | .001 |
| s20 | -.005 | -.004 | -.003 | -.004 | -.004 |
| s21 | .015 | .012 | .012 | .011 | .011 |
| s22 | .027 | .024 | .025 | .023 | .023 |
| s23 | -.003 | -.003 | -.002 | -.003 | -.004 |
| s24 | -.004 | -.003 | -.002 | -.003 | -.004 |
| s25 | -.012 | -.009 | -.009 | -.010 | -.011 |
| s26 | -.033 | -.009 | -.008 | -.009 | -.009 |
| s27 | .012 | -.009 | .012 | .013 | .013 |
| s28 | -.012 | -.011 | -.067 | -.010 | -.010 |
| s29 | -.010 | -.009 | -.009 | .016 | -.011 |
| s30 | -.008 | -.007 | -.007 | -.007 | .004 |

| | sex2 | race2 | race3 | race4 | race5 |
|---|---|---|---|---|---|
| s2 | -.011 | -.005 | -.002 | .010 | .015 |
| s3 | -.032 | -.003 | -.001 | -.004 | .002 |
| s4 | .036 | .021 | .006 | .001 | .001 |
| s5 | .038 | .016 | .015 | .010 | .020 |
| s6 | .029 | .007 | .003 | .009 | .010 |
| s7 | -.020 | -.019 | -.010 | .002 | -.000 |
| s8 | -.001 | -.010 | .004 | -.004 | .000 |
| s9 | .009 | -.011 | -.009 | .005 | -.021 |
| s10 | .014 | -.012 | -.001 | -.002 | -.006 |
| s11 | .007 | -.011 | -.001 | -.009 | .005 |
| s12 | -.019 | .019 | .026 | .002 | .021 |
| s13 | -.014 | .036 | .022 | .016 | .022 |
| s14 | -.016 | .029 | .032 | .010 | .009 |
| s15 | .015 | -.012 | -.008 | -.005 | -.008 |
| s16 | .014 | -.016 | .001 | -.002 | -.005 |
| s17 | .025 | -.010 | .000 | -.010 | -.005 |
| s18 | .034 | .013 | .010 | -.002 | .008 |
| s19 | .002 | -.019 | .021 | -.004 | .024 |
| s20 | .017 | -.003 | .010 | -.005 | .011 |
| s21 | .008 | .002 | -.004 | -.010 | -.003 |
| s22 | .004 | .013 | .004 | .004 | -.001 |
| s23 | .007 | .008 | .005 | .009 | .007 |
| s24 | .017 | .005 | .010 | .014 | -.002 |

| | | | | | |
|---|---|---|---|---|---|
| s25 | -.003 | -.002 | .011 | .006 | .004 |
| s26 | .016 | -.006 | -.001 | -.001 | -.000 |
| s27 | .000 | -.006 | -.013 | .010 | .009 |
| s28 | -.008 | -.014 | -.019 | -.010 | -.000 |
| s29 | -.004 | -.034 | -.009 | -.007 | -.011 |
| s30 | .001 | -.011 | -.020 | -.017 | -.001 |

| | race6 | regi2 | regi3 | regi4 | stoc2 |
|---|---|---|---|---|---|
| s2 | .012 | .012 | -.007 | .007 | .008 |
| s3 | .007 | .018 | .005 | .008 | -.013 |
| s4 | .009 | .026 | .015 | .021 | .011 |
| s5 | .009 | .022 | .008 | .013 | .005 |
| s6 | .008 | .022 | .012 | .025 | .003 |
| s7 | .003 | .021 | .022 | .024 | .005 |
| s8 | .003 | .019 | .025 | .024 | .010 |
| s9 | .014 | .016 | .003 | .017 | .003 |
| s10 | -.005 | .022 | .014 | .021 | -.008 |
| s11 | -.006 | .026 | .018 | .025 | -.002 |
| s12 | -.000 | .030 | .012 | .023 | .017 |
| s13 | .012 | .026 | .021 | .029 | .026 |
| s14 | .013 | .026 | .017 | .029 | .008 |
| s15 | .001 | .016 | -.003 | .009 | .000 |
| s16 | -.006 | .023 | .002 | .012 | .009 |
| s17 | -.008 | .017 | .013 | .012 | .004 |
| s18 | .020 | .020 | .008 | .016 | .003 |
| s19 | -.008 | .026 | .011 | .013 | .019 |
| s20 | -.012 | .019 | .017 | .014 | .011 |
| s21 | .003 | .001 | .008 | .006 | .008 |
| s22 | .002 | -.007 | .012 | .003 | .004 |
| s23 | .006 | .025 | .016 | .020 | .009 |
| s24 | .005 | .029 | .012 | .016 | .004 |
| s25 | .005 | .017 | .010 | .023 | .015 |
| s26 | .005 | .022 | .006 | .025 | .013 |
| s27 | -.000 | .008 | -.002 | .006 | -.012 |
| s28 | .006 | .010 | -.000 | .009 | .007 |
| s29 | .003 | .009 | .012 | .015 | .010 |
| s30 | .004 | .003 | .001 | .011 | .006 |

| | stoc3 | stoc4 | stoc5 | stoc6 | stoc7 |
|---|---|---|---|---|---|
| s2 | -.001 | .004 | -.003 | -.002 | -.000 |
| s3 | -.007 | -.007 | -.012 | -.014 | -.006 |
| s4 | -.015 | -.003 | -.007 | -.011 | -.011 |

| | | | | | |
|---|---|---|---|---|---|
| s5 | -.003 | .004 | -.003 | -.005 | -.002 |
| s6 | -.016 | -.000 | -.010 | -.008 | -.008 |
| s7 | .001 | .002 | -.003 | -.006 | .010 |
| s8 | .002 | .007 | -.002 | .003 | .008 |
| s9 | -.009 | -.004 | -.010 | -.005 | -.003 |
| s10 | -.015 | -.009 | -.016 | -.012 | -.014 |
| s11 | -.013 | -.001 | -.011 | -.009 | -.007 |
| s12 | -.021 | -.001 | -.011 | -.010 | -.002 |
| s13 | -.008 | .010 | -.001 | .009 | .009 |
| s14 | -.010 | -.003 | -.013 | -.002 | .000 |
| s15 | -.011 | -.003 | -.019 | -.008 | -.003 |
| s16 | -.011 | -.003 | -.016 | -.014 | -.007 |
| s17 | -.017 | -.004 | -.012 | -.016 | -.006 |
| s18 | -.008 | .002 | -.011 | -.008 | -.004 |
| s19 | .006 | .015 | .008 | .007 | .005 |
| s20 | .006 | .011 | -.003 | .003 | .001 |
| s21 | -.003 | .007 | .006 | .003 | .006 |
| s22 | -.010 | -.001 | .006 | -.003 | .002 |
| s23 | -.011 | -.001 | -.004 | -.001 | .001 |
| s24 | -.007 | .002 | -.008 | -.007 | -.004 |
| s25 | .007 | .011 | .006 | .006 | .010 |
| s26 | -.008 | .012 | -.004 | .001 | .002 |
| s27 | -.011 | -.011 | -.005 | -.012 | -.014 |
| s28 | -.004 | .007 | -.003 | -.001 | .003 |
| s29 | .011 | .011 | .009 | .010 | .013 |
| s30 | .004 | .003 | -.008 | .008 | -.001 |

| | pare2 | pare3 | pare4 | pare5 | pare6 |
|---|---|---|---|---|---|
| s2 | .007 | .011 | .007 | .010 | .008 |
| s3 | .004 | .003 | .000 | .009 | .007 |
| s4 | -.007 | -.008 | -.018 | -.007 | -.004 |
| s5 | .002 | .001 | -.003 | .007 | .004 |
| s6 | -.000 | -.001 | -.006 | .002 | .003 |
| s7 | -.004 | -.005 | -.009 | -.002 | -.000 |
| s8 | .005 | .004 | .001 | .007 | .009 |
| s9 | .001 | .002 | -.002 | .005 | .005 |
| s10 | -.004 | -.002 | -.007 | .003 | .003 |
| s11 | -.005 | -.004 | -.005 | .003 | -.001 |
| s12 | -.011 | -.005 | -.018 | -.006 | -.006 |
| s13 | -.004 | -.004 | -.014 | -.006 | -.003 |
| s14 | .001 | -.004 | -.011 | -.001 | -.000 |
| s15 | -.002 | -.005 | -.006 | -.001 | .002 |
| s16 | -.008 | -.009 | -.012 | -.006 | -.007 |

| | | | | | |
|---|---|---|---|---|---|
| s17 | .001 | -.000 | -.006 | .002 | .002 |
| s18 | -.001 | .000 | -.004 | .001 | .002 |
| s19 | -.012 | -.013 | -.019 | -.011 | -.012 |
| s20 | -.009 | -.00 | -.010 | -.003 | -.002 |
| s21 | -.019 | -.016 | -.023 | -.021 | -.016 |
| s22 | -.028 | -.030 | -.035 | -.032 | -.025 |
| s23 | -.005 | -.007 | -.010 | -.002 | -.002 |
| s24 | -.007 | -.003 | -.009 | -.003 | .000 |
| s25 | -.002 | -.001 | -.007 | .002 | .003 |
| s26 | -.003 | .002 | -.003 | .005 | .004 |
| s27 | -.014 | -.011 | -.012 | -.012 | -.008 |
| s28 | .008 | .012 | .011 | .014 | .010 |
| s29 | -.002 | .003 | .005 | .007 | .005 |
| s30 | .005 | .003 | .001 | .008 | .006 |

| | s2 | s3 | s4 | s5 | s6 |
|---|---|---|---|---|---|
| s2 | 1.0 | | | | |
| s3 | .678 | 1.0 | | | |
| s4 | .632 | .633 | 1.0 | | |
| s5 | .623 | .628 | .670 | 1.0 | |
| s6 | .632 | .647 | .685 | .652 | 1.0 |
| s7 | .646 | .679 | .651 | .626 | .647 |
| s8 | .521 | .529 | .524 | .505 | .539 |
| s9 | .643 | .668 | .647 | .631 | .653 |
| s10 | .663 | .684 | .670 | .653 | .674 |
| s11 | .673 | .697 | .676 | .662 | .678 |
| s12 | .698 | .718 | .704 | .688 | .710 |
| s13 | .673 | .693 | .686 | .669 | .684 |
| s14 | .699 | .722 | .706 | .692 | .710 |
| s15 | .547 | .567 | .553 | .540 | .556 |
| s16 | .652 | .672 | .656 | .638 | .658 |
| s17 | .595 | .618 | .607 | .586 | .609 |
| s18 | .622 | .644 | .630 | .620 | .630 |
| s19 | .601 | .625 | .604 | .588 | .601 |
| s20 | .585 | .603 | .594 | .578 | .606 |
| s21 | .649 | .666 | .661 | .640 | .657 |
| s22 | .654 | .678 | .670 | .649 | .668 |
| s23 | .692 | .717 | .699 | .680 | .700 |
| s24 | .669 | .692 | .679 | .662 | .679 |
| s25 | .642 | .665 | .649 | .632 | .653 |
| s26 | .652 | .673 | .658 | .641 | .663 |
| s27 | .134 | .142 | .142 | .133 | .144 |
| s28 | .269 | .277 | .274 | .261 | .274 |

| | | | | | |
|---|---|---|---|---|---|
| s29 | .493 | .502 | .498 | .487 | .508 |
| s30 | .532 | .555 | .538 | .526 | .532 |

| | s7 | s8 | s9 | s10 | s11 |
|---|---|---|---|---|---|
| s7 | 1.0 | | | | |
| s8 | .598 | 1.0 | | | |
| s9 | .663 | .541 | 1.0 | | |
| s10 | .679 | .557 | .686 | 1.0 | |
| s11 | .691 | .565 | .697 | .711 | 1.0 |
| s12 | .716 | .585 | .688 | .724 | .725 |
| s13 | .688 | .560 | .666 | .684 | .694 |
| s14 | .713 | .586 | .696 | .721 | .728 |
| s15 | .562 | .463 | .572 | .590 | .597 |
| s16 | .674 | .544 | .672 | .696 | .699 |
| s17 | .618 | .507 | .618 | .636 | .645 |
| s18 | .633 | .515 | .644 | .655 | .666 |
| s19 | .607 | .482 | .602 | .620 | .630 |
| s20 | .599 | .488 | .590 | .612 | .619 |
| s21 | .672 | .547 | .656 | .675 | .684 |
| s22 | .680 | .555 | .665 | .683 | .692 |
| s23 | .709 | .582 | .694 | .716 | .729 |
| s24 | .686 | .560 | .678 | .695 | .706 |
| s25 | .669 | .545 | .652 | .670 | .679 |
| s26 | .671 | .549 | .661 | .676 | .688 |
| s27 | .139 | .119 | .138 | .141 | .143 |
| s28 | .269 | .236 | .273 | .283 | .279 |
| s29 | .516 | .422 | .506 | .518 | .527 |
| s30 | .548 | .455 | .548 | .556 | .566 |

| | s12 | s13 | s14 | s15 | s16 |
|---|---|---|---|---|---|
| s12 | 1.0 | | | | |
| s13 | .787 | 1.0 | | | |
| s14 | .798 | .771 | 1.0 | | |
| s15 | .588 | .565 | .593 | 1.0 | |
| s16 | .702 | .669 | .700 | .577 | 1.0 |
| s17 | .644 | .619 | .649 | .532 | .658 |
| s18 | .671 | .646 | .673 | .547 | .664 |
| s19 | .653 | .630 | .652 | .517 | .615 |
| s20 | .640 | .618 | .638 | .505 | .600 |
| s21 | .712 | .682 | .706 | .560 | .665 |
| s22 | .721 | .691 | .719 | .565 | .674 |
| s23 | .759 | .733 | .761 | .595 | .703 |

| | | | | | |
|---|---|---|---|---|---|
| s24 | .731 | .707 | .732 | .577 | .682 |
| s25 | .700 | .676 | .707 | .554 | .660 |
| s26 | .712 | .688 | .718 | .562 | .669 |
| s27 | .146 | .141 | .148 | .119 | .137 |
| s28 | .287 | .276 | .289 | .230 | .273 |
| s29 | .538 | .510 | .540 | .425 | .508 |
| s30 | .571 | .558 | .577 | .462 | .549 |

| | s17 | s18 | s19 | s20 | s21 |
|---|---|---|---|---|---|
| s17 | 1.0 | | | | |
| s18 | .608 | 1.0 | | | |
| s19 | .558 | .583 | 1.0 | | |
| s20 | .549 | .578 | .579 | 1.0 | |
| s21 | .616 | .638 | .602 | .593 | 1.0 |
| s22 | .624 | .647 | .607 | .602 | .742 |
| s23 | .651 | .675 | .646 | .635 | .695 |
| s24 | .632 | .653 | .634 | .618 | .671 |
| s25 | .610 | .626 | .609 | .595 | .644 |
| s26 | .617 | .634 | .617 | .605 | .643 |
| s27 | .127 | .128 | .125 | .128 | .137 |
| s28 | .251 | .265 | .250 | .241 | .270 |
| s29 | .473 | .484 | .461 | .462 | .503 |
| s30 | .506 | .526 | .502 | .497 | .535 |

| | s22 | s23 | s24 | s25 | s26 |
|---|---|---|---|---|---|
| s22 | 1.0 | | | | |
| s23 | .712 | 1.0 | | | |
| s24 | .679 | .740 | 1.0 | | |
| s25 | .657 | .710 | .690 | 1.0 | |
| s26 | .658 | .710 | .707 | .684 | 1.0 |
| s27 | .150 | .145 | .151 | .139 | .162 |
| s28 | .270 | .287 | .285 | .273 | .276 |
| s29 | .510 | .539 | .524 | .514 | .508 |
| s30 | .543 | .579 | .564 | .540 | .550 |

| | s27 | s28 | s29 | s30 |
|---|---|---|---|---|
| s27 | 1.0 | | | |
| s28 | .074 | 1.0 | | |
| s29 | .104 | .205 | 1.0 | |
| s30 | .113 | .239 | .367 | 1.0 |