**PUBLIC PERCEPTIONS OF AUTONOMOUS VEHICLE SAFETY:   
AN INTERNATIONAL COMPARISON**

**WAMBS-Checklist[[1]](#footnote-1) Supplementary Material**

## STAGE 1: TO BE CHECKED BEFORE ESTIMATING THE MODEL

## Point 1: Do you understand the priors?

First we consider the prior distributions and hyperparameters for our model. Because we lack any a-priori information regarding the relations of interest, we will use diffuse (non-informative) parameters for all priors. Therefore the Mplus software default priors (summarized in Table 1) will suffice.

Table 1. Diffuse (non-informative) default priors in Mplus 8.1

|  |  |  |  |
| --- | --- | --- | --- |
| Parameter type | | Distributional form of the prior | Hyperparameters |
| Observed continuous dependent variables | Means  Intercepts | Normal | N(0, infinity) |
| Variances  Residual variances | Inverse Gamma | IG(-1, 0) |
| Observed categorical dependent variables | Thresholds | Normal | N(0, infinity) |
| Regression coefficients  (and factor loadings) | Continuous  Categorical | Normal | N(0, infinity)  N(0, 5) |
| Covariance matrix |  | Inverse Wishart | IW(0, -p-1), p = dimension of covariance matrix[[2]](#footnote-2) |
| Continuous latent variable | Means  Intercepts | Normal | N(0, infinity) |
| Variances  Residual variances | Inverse Gamma  Inverse Wishart | IG(-1,0) (for 1 latent variable)  IW(0, -p-1) (for > 1 latent variable) |

For the 40 estimated parameters in our model, the priors are given as:

|  |  |
| --- | --- |
| Parameter | Prior |
| 1. %WITHIN% Q16 ON AGE | N(0, 5) |
| 1. %WITHIN% Q16 ON GEN | N(0, 5) |
| 1. %WITHIN% Q16 ON EMPC | N(0, 5) |
| 1. %WITHIN% Q16 ON LOG\_ESS | N(0, 5) |
| 1. %WITHIN% Q16 ON INC | N(0, 5) |
| 1. %WITHIN% Q16 ON EDU\_HIGH | N(0, 5) |
| 1. %WITHIN% Q16 ON CAROWN | N(0, 5) |
| 1. %WITHIN% Q16 ON Q01D | N(0, 5) |
| 1. %WITHIN% SAFEPERC14 ON AGE | N(0, 5) |
| 1. %WITHIN% SAFEPERC14 ON GEN | N(0, 5) |
| 1. %WITHIN% SAFEPERC14 ON EMPC | N(0, 5) |
| 1. %WITHIN% SAFEPERC14 ON LOG\_ESS | N(0, 5) |
| 1. %WITHIN% SAFEPERC14 ON INC | N(0, 5) |
| 1. %WITHIN% SAFEPERC14 ON EDU\_HIGH | N(0, 5) |
| 1. %WITHIN% SAFEPERC14 ON CAROWN | N(0, 5) |
| 1. %WITHIN% SAFEPERC14 ON Q01D | N(0, 5) |
| 1. %WITHIN% SAFEPRED ON AGE | N(0, infinity) |
| 1. %WITHIN% SAFEPRED ON GEN | N(0, infinity) |
| 1. %WITHIN% SAFEPRED ON EMPC | N(0, infinity) |
| 1. %WITHIN% SAFEPRED ON LOG\_ESS | N(0, infinity) |
| 1. %WITHIN% SAFEPRED ON INC | N(0, infinity) |
| 1. %WITHIN% SAFEPRED ON EDU\_HIGH | N(0, infinity) |
| 1. %WITHIN% SAFEPRED ON CAROWN | N(0, infinity) |
| 1. %WITHIN% SAFEPRED ON Q01D | N(0, infinity) |
| 1. %WITHIN% SAFEPERC14 WITH Q16 | IW(0, 4) |
| 1. %WITHIN% SAFEPRED WITH Q16 | IW(0, 4) |
| 1. %WITHIN% SAFEPRED WITH SAFEPERC14 | IW(0, 4) |
| 1. %WITHIN% SAFEPRED (residual variance) | IW(0, 4) |
| 1. %BETWEEN% [SAFEPRED] (mean) | N(0, infinity) |
| 1. %BETWEEN% Q16 (variance) | IW(1, 4) |
| 1. %BETWEEN% SAFEPERC14 WITH Q16 | IW(0, 4) |
| 1. %BETWEEN% SAFEPERC14 (variance) | IW(1, 4) |
| 1. %BETWEEN% SAFEPRED WITH Q16 | IW(0, 4) |
| 1. %BETWEEN% SAFEPRED WITH SAFEPERC14 | IW(0, 4) |
| 1. %BETWEEN% SAFEPRED (variance) | IW(1, 4) |
| 1. %BETWEEN% [Q16$1] (threshold) | N(0, 5) |
| 1. %BETWEEN% [Q16$2] (threshold) | N(0, 5) |
| 1. %BETWEEN% [SAFEPERC14$1] (threshold) | N(0, 5) |
| 1. %BETWEEN% [SAFEPERC14$2] (threshold) | N(0, 5) |
| 1. %BETWEEN% [SAFEPERC14$3] (threshold) | N(0, 5) |

## STAGE 2: TO BE CHECKED AFTER ESTIMATION BUT BEFORE INSPECTING MODEL RESULTS

## Point 2: Does the trace-plot exhibit convergence?

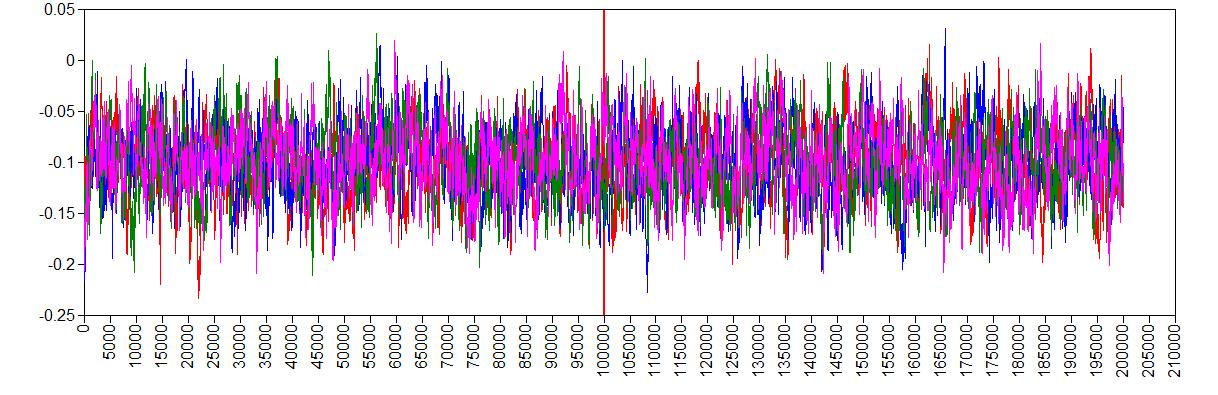
We used the file ‘20190629\_FullModel\_Bayes\_pairwisecomp\_200000.inp’ to run the Bayesian MSEM. We specified a maximum and minimum number of iterations as well as a stricter Rubin and Gelman convergence criterion by adding the following lines to the ANALYSIS part of the input:

BITERATIONS = 300000 (200000);

BCONVERGENCE = 0.01;

In the input file, we have left the MODEL PRIORS: section blank so that the program uses default priors (see point 1 above).

We also added OUTPUT: TECH8; and PLOTS: TYPE = PLOT2; to the model syntax to obtain convergence diagnostics. To check convergence for all parameters, we use the Gelman and Rubin diagnostic (1992). This diagnostic should be close to 1.00 (at least < 1.05) to indicate convergence. You can find this diagnostic in the TECH8 output under Potential Scale Reduction. By the final (200,000th) iteration, the greatest potential scale reduction factor was 1.002 < 1.05 for parameter #39: %BETWEEN% [SAFEPERC14$2] (threshold). The corresponding traceplot is seen directly below. All other traceplots showed all four chains converging with similar mean and standard deviation (see the figures in the corresponding folder)



## Point 3: Does convergence remain after doubling the number of iterations?

To be absolutely sure the model reached convergence, we re-run the model with twice the number of iterations (400,000 in total) and compute the relative bias according to: [(estimate from initial model) – (estimate from expanded model)/(estimate from initial model)] x 100. The results are given in Table 2. We find that results are almost identical, with relative deviation levels no more than |1|% for all parameters.

Table 2. Parameter bias when doubling the number of iterations

| Parameter | Unstandardized estimate | |  |
| --- | --- | --- | --- |
| Initial Model (200,000) | Expanded Model (400,000) | Bias (%) |
| %WITHIN% Q16 ON AGE | -0.005 | -0.005 | 0.0 |
| %WITHIN% Q16 ON GEN | 0.287 | 0.287 | 0.0 |
| %WITHIN% Q16 ON EMPC | 0.014 | 0.014 | 0.0 |
| %WITHIN% Q16 ON LOG\_ESS | 0.014 | 0.014 | 0.0 |
| %WITHIN% Q16 ON INC | 0.003 | 0.003 | 0.0 |
| %WITHIN% Q16 ON EDU\_HIGH | 0.205 | 0.205 | 0.0 |
| %WITHIN% Q16 ON CAROWN | 0.166 | 0.166 | 0.0 |
| %WITHIN% Q16 ON Q01D | 0.088 | 0.088 | 0.0 |
| %WITHIN% SAFEPERC14 ON AGE | -0.004 | -0.004 | 0.0 |
| %WITHIN% SAFEPERC14 ON GEN | 0.182 | 0.182 | 0.0 |
| %WITHIN% SAFEPERC14 ON EMPC | 0.055 | 0.055 | 0.0 |
| %WITHIN% SAFEPERC14 ON LOG\_ESS | -0.001 | -0.001 | 0.0 |
| %WITHIN% SAFEPERC14 ON INC | 0.002 | 0.002 | 0.0 |
| %WITHIN% SAFEPERC14 ON EDU\_HIGH | 0.104 | 0.104 | 0.0 |
| %WITHIN% SAFEPERC14 ON CAROWN | 0.060 | 0.060 | 0.0 |
| %WITHIN% SAFEPERC14 ON Q01D | 0.027 | 0.027 | 0.0 |
| %WITHIN% SAFEPRED ON AGE | 0.058 | 0.058 | 0.0 |
| %WITHIN% SAFEPRED ON GEN | -1.173 | -1.173 | 0.0 |
| %WITHIN% SAFEPRED ON EMPC | -1.223 | -1.223 | 0.0 |
| %WITHIN% SAFEPRED ON LOG\_ESS | -0.140 | -0.140 | 0.0 |
| %WITHIN% SAFEPRED ON INC | -0.017 | -0.017 | 0.0 |
| %WITHIN% SAFEPRED ON EDU\_HIGH | -1.446 | -1.446 | 0.0 |
| %WITHIN% SAFEPRED ON CAROWN | -1.216 | -1.216 | 0.0 |
| %WITHIN% SAFEPRED ON Q01D | -0.697 | -0.698 | -0.1 |
| %WITHIN% SAFEPERC14 WITH Q16 | 0.387 | 0.387 | 0.0 |
| %WITHIN% SAFEPRED WITH Q16 | -3.280 | -3.280 | 0.0 |
| %WITHIN% SAFEPRED WITH SAFEPERC14 | -6.931 | -6.931 | 0.0 |
| %WITHIN% SAFEPRED (residual variance) | 161.739 | 161.738 | 0.0 |
| %BETWEEN% [SAFEPRED] (mean) | 10.540 | 10.534 | 0.1 |
| %BETWEEN% Q16 (variance) | 0.134 | 0.135 | -0.7 |
| %BETWEEN% SAFEPERC14 WITH Q16 | 0.005 | 0.005 | 0.0 |
| %BETWEEN% SAFEPERC14 (variance) | 0.052 | 0.052 | 0.0 |
| %BETWEEN% SAFEPRED WITH Q16 | -0.027 | -0.027 | 0.0 |
| %BETWEEN% SAFEPRED WITH SAFEPERC14 | -0.274 | -0.274 | 0.0 |
| %BETWEEN% SAFEPRED (variance) | 4.870 | 4.869 | 0.0 |
| %BETWEEN% [Q16$1] (threshold) | -0.722 | -0.719 | 0.4 |
| %BETWEEN% [Q16$2] (threshold) | 0.948 | 0.951 | -0.3 |
| %BETWEEN% [SAFEPERC14$1] (threshold) | -1.235 | -1.235 | 0.0 |
| %BETWEEN% [SAFEPERC14$2] (threshold) | -0.099 | -0.100 | -1.0 |
| %BETWEEN% [SAFEPERC14$3] (threshold) | 1.191 | 1.190 | 0.1 |

## Point 4: Does the posterior distribution histogram have enough precision?

Yes! See the posterior distribution histograms in the corresponding folder.

## Point 5: Do the chains exhibit a strong degree of autocorrelation

Most variables do not exhibit a strong degree of autocorrelation in any of the four chains. However, the country- or between-level threshold parameters for the ordinal outcome variables Q16 (level of awareness) and SAFEPERC14 (current perceptions of AV safety) do exhibit significant autocorrelation. See the autocorrelation plots for parameters 36-40 in the corresponding folder. Despite the chains having high levels of dependency for these parameters, convergence is obtained and the model exhibits good model fit and does not have any other indications of poor estimation, we ignore this autocorrelation.

To remove or reduce the amount of autocorrelation in the chain, some researchers will employ thinning, where every *i*-th sample (*i* > 1) is selected to form the post burn-in samples to lessen the dependency in the posterior. However, thinning is typically not viewed as optimal because of the impact it can have on sample variance estimates for parameters (Geyer, 1991; Link & Eaton, 2012). Specifically, when a chain is thinned, sample variance estimates from the iterations must be down-weighted to account for larger lags (or higher thinning intervals) in order to produce a decent variance estimate (Depaoli & van de Schoot, 2017). Therefore, we do not employ any thinning.

## Point 6: Does the posterior distribution make substantive sense?

## Yes! See the kernel density plots in the corresponding folder.

## STAGE 3: UNDERSTANDING THE EXACT INFLUENCE OF THE PRIORS

Because our model does not incorporate any weakly or strongly informative priors, we can skip this stage of the checklist (points 7-9).

**Point 7: Do different specification of the multivariate variance priors influence the results?**

**Point 8: Is there a notable effect of the prior when compared with non-informative priors?**

**Point 9: Are the results stable from a sensitivity analysis?**

## STAGE 4: AFTER INTERPRETATION OF MODEL RESULTS

## Point 10: Is the Bayesian way of interpreting and reporting model results used? \*also report on missing data, model fit and comparison, non-response, generalizability, ability to replicate, etc.

Yes! See the paper for presentation of results and discussion.

1. Depaoli, Sarah and Rens van de Schoot. (2017). Improving Transparency and Replication in Bayesian Statistics: The WAMBS Checklist. *Psychological Methods*, 22(2): 240-261. [↑](#footnote-ref-1)
2. Alternative non-informative priors include IW(0,0) and IW(I, p+1), where diagonal elements are distributed as IG(1, 0.5) (Asparouhov &Muthén, 2010, p. 35) [↑](#footnote-ref-2)