Stage 2 simulation results

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Overview

We will perform a simulation study to explore the recovery of parameters

Data generating mechanism

Let $r = 1, \ldots, R$ index region and $c = 1, 2$ index outcomes. The region-level means will be generated as

$$\begin{aligned}
\mu_{r1} &= \beta_1 + v_{r1} + u_{r1} + \lambda(v_{r2} + u_{r2}) \\
\mu_{r2} &= \beta_2 + v_{r2} + u_{r2} \\
v_{r1}|\sigma_1^2 &\overset{iid}{\sim} N(0, \sigma_1^2) \\
v_{r2}|\sigma_2^2 &\overset{iid}{\sim} N(0, \sigma_2^2) \\
\boldsymbol{u}_1 &\sim ICAR(1) \\
\boldsymbol{u}_2 &\sim ICAR(1)
\end{aligned}$$

with β_c set to be the estimated intercept and σ_c^2 set to be the estimated variances of the random effects from a model fit to the 2014 KDHS HAZ and WAZ data. The random effects will only be simulated once and the same ones will be used across all simulations.

We will use a BYM2 parameterization for the spatial and IID random effects in each model such that, for $c = 1, 2$, we let

$$v_{rc} + u_{rc} = \sigma_c(\sqrt{1 - \rho_c}v_{cr}^* + \sqrt{\rho_c}u_{cr}^*)$$

where $v_{cr}^* \overset{iid}{\sim} N(0, 1)$ is the unstructured random effect with fixed standard deviation 1 and $\boldsymbol{u}_r^*$ is the ICAR model scaled so $\text{Var}(u_{cr}^*) \approx 1$, which is done by scaling the model so the geometric mean of these variances is 1, using the adjacency matrix to calculate the inverse precision of the ICAR model as in Riebler et al. (2016).

Once we have these μ_{rc} values, we will simulate the area-level sample means as

$$\hat{\boldsymbol{y}}_r|\boldsymbol{\mu}_r, \boldsymbol{V}_r \sim N_2(\boldsymbol{\mu}_r, \boldsymbol{V}_r)$$

where the $\boldsymbol{V}_r$ are set to be equal to the estimated asymptotic design-based covariance matrix of the area-level mean HAZ and WAZ from the 2014 KDHS data.

Now, for an SRS, the sampling distribution of the area-level sample covariance matrices is

$$(n_r - 1)\hat{\boldsymbol{V}}_r^{srs} | V_r, n_r \sim \text{Wishart}\left(\boldsymbol{V}_r, (n_r - 1)\right)$$

where n_r is the sample size in area r. The 2014 KDHS uses a stratified cluster design rather than an SRS, which has a different sampling variance than an SRS. The ratio of the variance for a statistic calculated using a specific survey design to the variance of that statistic calculated using an SRS of the same sample size is called the design effect,

$$d^2 = \frac{\hat{V}}{\hat{V}^{srs}}.$$

In the a typical DHS, the average design effect across all indicators is $d^2 = 1.5^2 = 2.25$ (taken from this answer on the DHS user forum: https://userforum.dhsprogram.com/index.php?t=msg&goto=3448&S=Google). Then, the effective sample size in the stratified design is approximately equal to $n_r^* = n_r/(d^2)$, since the sample variance is linear with respect to the sample size. Thus, we calculate n_r^* as the observed sample size in region r divided by 2.25 and use this to adjust for the survey design effect, giving us

$$\hat{\boldsymbol{V}}_r | \boldsymbol{V}_r, n_r^* \sim \frac{1}{(n_r^* - 1)} \text{Wishart}\left(\boldsymbol{V}_r, (n_r^* - 1)\right).$$

In each simulation, we will have the same values of μ_r and V_r, and we use these to simulate $\hat{\boldsymbol{y}}_r$ and $\hat{\boldsymbol{V}}_r$. We will treat the $\hat{\boldsymbol{y}}_r$ as pseudo-direct estimates and calculate asymptotic 95% confidence intervals as $\hat{y}_{rc} \pm z_{0.975}\sqrt{\hat{V}_{r,cc}}$ with $\hat{V}_{r,cc}$ the diagonal entries of the sampled covariance matrix.

We will also fit six different smoothing models to the pseudo-direct estimates to estimate the latent means in each region with corresponding 95% credible intervals. They will be:

1. Univariate IID
2. Univariate BYM
3. Bivariate nonshared IID
4. Bivariate nonshared BYM
5. Bivariate shared IID
6. Bivariate shared BYM

All data will be the same size as the Kenya 2014 DHS (47 regions). The DGM parameters will be set equal to those estimated from models fit to the Kenya 2014 DHS HAZ/WAZ data. We run 100 simulations.

Results

All results

Table 1: Model:Direct estimates

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	0	0.074	0.080	0.798	0.239	0.948	0.365
WAZ latent means	0	0.067	0.084	0.797	0.215	0.947	0.328

Table 2: Model:Univariate IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.016	0.017	0.018	0.986	0.090	1.000	0.139
beta[2]	0.010	0.012	0.014	0.999	0.090	1.000	0.140
sigma[1]	0.033	0.033	0.180	0.430	0.069	0.870	0.107
sigma[2]	-0.025	0.026	0.102	0.806	0.068	0.993	0.105
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.003	0.067	0.073	0.801	0.217	0.950	0.332
WAZ latent means	-0.001	0.062	0.078	0.802	0.200	0.950	0.306

Table 3: Model:Univariate BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.018	0.019	0.019	0.839	0.063	0.991	0.099
beta[2]	0.011	0.013	0.015	0.953	0.064	1.000	0.103
sigma[1]	0.028	0.028	0.151	0.666	0.073	0.961	0.114
sigma[2]	-0.018	0.019	0.076	0.955	0.078	1.000	0.120
rho[1]	-0.285	0.285	0.330	0.503	0.594	0.937	0.781
rho[2]	-0.339	0.339	0.373	0.216	0.646	0.839	0.826
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.004	0.067	0.073	0.794	0.213	0.948	0.327
WAZ latent means	0.000	0.061	0.078	0.803	0.199	0.949	0.304

Table 4: Model:Bivariate nonshared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.016	0.017	0.017	0.977	0.084	1.000	0.130
beta[2]	0.010	0.013	0.015	0.997	0.084	1.000	0.131
sigma[1]	0.017	0.018	0.097	0.868	0.064	0.994	0.099
sigma[2]	-0.042	0.042	0.167	0.298	0.064	0.834	0.098
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.003	0.069	0.076	0.767	0.206	0.932	0.316
WAZ latent means	0.000	0.063	0.080	0.767	0.188	0.932	0.288

Table 5: Model:Bivariate nonshared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.018	0.019	0.019	0.780	0.056	0.974	0.088
beta[2]	0.013	0.014	0.016	0.896	0.056	0.995	0.091
sigma[1]	0.008	0.013	0.068	0.968	0.068	1.000	0.104
sigma[2]	-0.039	0.039	0.156	0.496	0.071	0.931	0.110
rho[1]	-0.216	0.216	0.250	0.749	0.565	0.986	0.754
rho[2]	-0.272	0.272	0.299	0.417	0.616	0.950	0.803
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.004	0.071	0.078	0.746	0.200	0.916	0.307
WAZ latent means	0.002	0.064	0.082	0.749	0.184	0.919	0.282

Table 6: Model:Bivariate shared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.014	0.016	0.016	0.992	0.091	1.000	0.140
beta[2]	0.011	0.013	0.015	0.998	0.090	1.000	0.139
sigma[1]	-0.023	0.023	0.126	0.645	0.050	0.973	0.077
sigma[2]	-0.025	0.025	0.101	0.810	0.068	0.994	0.105
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	-0.125	0.126	0.160	0.720	0.320	0.974	0.489
HAZ latent means	0.001	0.066	0.072	0.803	0.216	0.951	0.331
WAZ latent means	0.001	0.061	0.077	0.801	0.198	0.949	0.302

Table 7: Model:Bivariate shared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.015	0.017	0.017	0.879	0.061	0.991	0.096
beta[2]	0.014	0.015	0.017	0.933	0.064	1.000	0.103
sigma[1]	-0.039	0.039	0.212	0.140	0.050	0.639	0.077
sigma[2]	-0.018	0.018	0.074	0.954	0.077	0.999	0.119
rho[1]	-0.150	0.150	0.174	0.924	0.500	0.996	0.685
rho[2]	-0.342	0.342	0.376	0.159	0.633	0.770	0.814
lambda	-0.090	0.093	0.119	0.828	0.286	0.986	0.437
HAZ latent means	0.002	0.066	0.072	0.797	0.212	0.950	0.324
WAZ latent means	0.003	0.061	0.077	0.798	0.196	0.948	0.300

Table 8: Model:Direct estimates

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	0.000	0.310	0.350	0.799	0.995	0.948	1.522
WAZ latent means	-0.001	0.306	0.379	0.796	0.980	0.947	1.499

Table 9: Model:Univariate IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.007	0.044	0.044	0.892	0.184	0.986	0.285
beta[2]	0.004	0.042	0.049	0.862	0.161	0.980	0.249
sigma[1]	0.110	0.120	0.646	0.379	0.197	0.576	0.298
sigma[2]	-0.060	0.083	0.334	0.632	0.180	0.854	0.269
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.007	0.218	0.246	0.735	0.600	0.905	0.946
WAZ latent means	-0.001	0.168	0.215	0.702	0.443	0.902	0.734

Table 10: Model:Univariate BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.008	0.044	0.044	0.846	0.161	0.974	0.249
beta[2]	0.002	0.042	0.048	0.848	0.154	0.975	0.237
sigma[1]	0.109	0.113	0.609	0.353	0.191	0.589	0.292
sigma[2]	-0.053	0.072	0.288	0.721	0.182	0.952	0.277

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
rho[1]	-0.208	0.208	0.241	0.888	0.621	0.994	0.806
rho[2]	-0.384	0.384	0.422	0.214	0.686	0.872	0.858
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.008	0.187	0.213	0.808	0.604	0.947	0.942
WAZ latent means	-0.003	0.153	0.196	0.787	0.489	0.945	0.783

Table 11: Model:Bivariate nonshared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.016	0.045	0.045	0.836	0.160	0.968	0.246
beta[2]	-0.007	0.042	0.048	0.831	0.144	0.958	0.221
sigma[1]	0.009	0.041	0.219	0.804	0.132	0.940	0.203
sigma[2]	-0.163	0.163	0.653	0.053	0.113	0.194	0.169
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.017	0.229	0.255	0.548	0.410	0.751	0.643
WAZ latent means	-0.012	0.181	0.236	0.446	0.268	0.683	0.451

Table 12: Model:Bivariate nonshared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.013	0.044	0.044	0.804	0.149	0.960	0.229
beta[2]	-0.002	0.041	0.047	0.824	0.143	0.964	0.219
sigma[1]	0.021	0.040	0.215	0.810	0.133	0.953	0.204
sigma[2]	-0.141	0.142	0.568	0.088	0.129	0.410	0.201
rho[1]	-0.179	0.179	0.207	0.917	0.602	0.998	0.791
rho[2]	-0.373	0.373	0.410	0.171	0.704	0.963	0.871
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.013	0.199	0.222	0.633	0.432	0.839	0.671
WAZ latent means	-0.007	0.169	0.218	0.556	0.319	0.784	0.520

Table 13: Model:Bivariate shared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.016	0.045	0.045	0.899	0.189	0.991	0.293
beta[2]	-0.006	0.042	0.048	0.874	0.165	0.981	0.254
sigma[1]	-0.019	0.050	0.269	0.715	0.131	0.923	0.197

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
sigma[2]	-0.036	0.065	0.260	0.724	0.169	0.891	0.254
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	0.349	0.463	0.590	0.530	1.010	0.730	1.540
HAZ latent means	0.016	0.210	0.232	0.765	0.619	0.923	0.964
WAZ latent means	-0.011	0.163	0.210	0.758	0.485	0.931	0.777

Table 14: Model:Bivariate shared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.016	0.045	0.045	0.839	0.161	0.971	0.248
beta[2]	-0.002	0.041	0.047	0.844	0.149	0.970	0.229
sigma[1]	-0.020	0.051	0.273	0.770	0.141	0.962	0.217
sigma[2]	-0.043	0.061	0.246	0.748	0.170	0.938	0.259
rho[1]	-0.292	0.292	0.337	0.662	0.674	0.982	0.848
rho[2]	-0.328	0.328	0.360	0.357	0.634	0.866	0.814
lambda	0.383	0.464	0.591	0.570	1.098	0.776	1.676
HAZ latent means	0.015	0.184	0.205	0.802	0.589	0.945	0.916
WAZ latent means	-0.007	0.151	0.195	0.756	0.450	0.931	0.722

Table 15: Model:Direct estimates

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	0	0.031	0.036	0.799	0.099	0.948	0.152
WAZ latent means	0	0.031	0.045	0.796	0.098	0.947	0.150

Table 16: Model:Univariate IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.003	0.005	0.005	1.000	0.120	1.000	0.185
beta[2]	-0.005	0.006	0.007	1.000	0.121	1.000	0.187
sigma[1]	0.129	0.129	0.696	0.000	0.085	0.000	0.131
sigma[2]	0.068	0.068	0.273	0.000	0.086	0.015	0.132
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.000	0.031	0.036	0.806	0.100	0.953	0.154

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
WAZ latent means	0.000	0.030	0.045	0.802	0.099	0.951	0.151

Table 17: Model:Univariate BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.003	0.005	0.005	1.000	0.053	1.000	0.090
beta[2]	-0.005	0.006	0.007	0.999	0.045	1.000	0.076
sigma[1]	0.122	0.122	0.658	0.000	0.088	0.000	0.136
sigma[2]	0.029	0.029	0.116	0.880	0.079	1.000	0.122
rho[1]	-0.051	0.051	0.059	1.000	0.403	1.000	0.589
rho[2]	-0.055	0.055	0.060	1.000	0.332	1.000	0.506
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.000	0.031	0.035	0.805	0.100	0.953	0.153
WAZ latent means	0.000	0.030	0.045	0.803	0.098	0.952	0.150

Table 18: Model:Bivariate nonshared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.003	0.005	0.005	1.000	0.119	1.000	0.184
beta[2]	-0.005	0.006	0.007	1.000	0.120	1.000	0.185
sigma[1]	0.127	0.127	0.682	0.000	0.084	0.000	0.130
sigma[2]	0.066	0.066	0.263	0.000	0.085	0.044	0.131
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.000	0.031	0.036	0.802	0.100	0.952	0.153
WAZ latent means	0.000	0.031	0.046	0.799	0.099	0.950	0.151

Table 19: Model:Bivariate nonshared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.003	0.005	0.005	1.000	0.051	1.000	0.088
beta[2]	-0.005	0.006	0.007	0.999	0.043	1.000	0.074
sigma[1]	0.117	0.117	0.633	0.000	0.086	0.000	0.133
sigma[2]	0.024	0.024	0.096	0.986	0.077	1.000	0.119
rho[1]	-0.044	0.045	0.052	1.000	0.392	1.000	0.576
rho[2]	-0.052	0.052	0.057	1.000	0.325	1.000	0.496
lambda	NA	NA	NA	NA	NA	NA	NA

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	0.000	0.031	0.036	0.800	0.099	0.951	0.152
WAZ latent means	0.000	0.030	0.046	0.798	0.098	0.949	0.149

Table 20: Model:Bivariate shared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.003	0.005	0.005	1.000	0.120	1.000	0.186
beta[2]	-0.005	0.006	0.007	1.000	0.120	1.000	0.185
sigma[1]	0.058	0.058	0.314	0.000	0.066	0.000	0.101
sigma[2]	0.068	0.068	0.273	0.000	0.086	0.013	0.132
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	-0.161	0.161	0.205	0.215	0.294	1.000	0.450
HAZ latent means	0.000	0.031	0.036	0.805	0.100	0.953	0.153
WAZ latent means	0.000	0.030	0.045	0.803	0.099	0.952	0.151

Table 21: Model:Bivariate shared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.003	0.005	0.005	1.000	0.049	1.000	0.081
beta[2]	-0.005	0.006	0.007	0.999	0.046	1.000	0.077
sigma[1]	0.010	0.010	0.053	0.989	0.053	1.000	0.082
sigma[2]	0.028	0.028	0.114	0.853	0.077	0.969	0.118
rho[1]	0.037	0.037	0.043	1.000	0.240	1.000	0.382
rho[2]	-0.060	0.060	0.066	0.983	0.321	0.998	0.480
lambda	0.091	0.091	0.116	0.936	0.264	0.988	0.405
HAZ latent means	0.000	0.031	0.035	0.805	0.100	0.953	0.153
WAZ latent means	0.000	0.030	0.045	0.804	0.098	0.952	0.150

Table 22: Model:Direct estimates

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	0	0.075	0.086	0.798	0.239	0.948	0.365
WAZ latent means	0	0.067	0.105	0.797	0.215	0.947	0.328

Table 23: Model:Univariate IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.004	0.011	0.011	1.000	0.113	1.000	0.174
beta[2]	-0.006	0.011	0.013	1.000	0.165	1.000	0.255
sigma[1]	0.098	0.098	0.527	0.000	0.084	0.000	0.130
sigma[2]	0.181	0.181	0.725	0.000	0.118	0.000	0.181
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.006	0.070	0.082	0.799	0.225	0.950	0.345
WAZ latent means	-0.001	0.065	0.103	0.800	0.211	0.949	0.323

Table 24: Model:Univariate BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.003	0.011	0.011	0.984	0.067	1.000	0.108
beta[2]	-0.006	0.011	0.012	0.970	0.057	1.000	0.095
sigma[1]	0.080	0.080	0.433	0.000	0.086	0.022	0.133
sigma[2]	0.083	0.083	0.334	0.000	0.098	0.035	0.151
rho[1]	-0.176	0.176	0.203	0.865	0.512	0.999	0.700
rho[2]	-0.022	0.023	0.025	1.000	0.281	1.000	0.437
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.005	0.069	0.080	0.800	0.220	0.949	0.337
WAZ latent means	0.000	0.063	0.099	0.801	0.205	0.950	0.313

Table 25: Model:Bivariate nonshared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.006	0.012	0.012	1.000	0.109	1.000	0.168
beta[2]	-0.011	0.013	0.015	1.000	0.160	1.000	0.247
sigma[1]	0.087	0.087	0.469	0.000	0.081	0.000	0.125
sigma[2]	0.166	0.166	0.664	0.000	0.114	0.000	0.175
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.008	0.072	0.085	0.782	0.222	0.941	0.339
WAZ latent means	-0.005	0.065	0.107	0.782	0.203	0.940	0.311

Table 26: Model:Bivariate nonshared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.004	0.011	0.011	0.978	0.061	1.000	0.099
beta[2]	-0.009	0.012	0.014	0.926	0.051	0.996	0.084
sigma[1]	0.062	0.062	0.334	0.020	0.081	0.237	0.125
sigma[2]	0.061	0.061	0.245	0.033	0.091	0.506	0.140
rho[1]	-0.132	0.132	0.153	0.965	0.480	1.000	0.666
rho[2]	-0.003	0.013	0.014	1.000	0.248	1.000	0.399
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.006	0.071	0.083	0.768	0.212	0.932	0.324
WAZ latent means	-0.004	0.065	0.104	0.766	0.194	0.931	0.297

Table 27: Model:Bivariate shared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.004	0.011	0.011	1.000	0.112	1.000	0.174
beta[2]	-0.010	0.013	0.014	1.000	0.164	1.000	0.253
sigma[1]	-0.019	0.019	0.104	0.789	0.051	0.989	0.079
sigma[2]	0.179	0.179	0.719	0.000	0.118	0.000	0.182
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	-0.256	0.256	0.325	0.000	0.162	0.000	0.248
HAZ latent means	-0.006	0.069	0.080	0.800	0.220	0.949	0.337
WAZ latent means	-0.004	0.064	0.102	0.799	0.207	0.949	0.317

Table 28: Model:Bivariate shared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.004	0.011	0.011	0.966	0.057	1.000	0.090
beta[2]	-0.009	0.012	0.014	0.950	0.056	0.999	0.093
sigma[1]	-0.025	0.025	0.133	0.659	0.053	0.952	0.082
sigma[2]	0.084	0.084	0.336	0.000	0.096	0.035	0.149
rho[1]	-0.112	0.113	0.130	0.959	0.461	0.995	0.647
rho[2]	-0.020	0.025	0.028	0.999	0.276	1.000	0.435
lambda	-0.139	0.139	0.177	0.214	0.216	0.732	0.331
HAZ latent means	-0.006	0.069	0.080	0.794	0.216	0.947	0.330
WAZ latent means	-0.004	0.063	0.099	0.798	0.202	0.948	0.309

Table 29: Model:Direct estimates

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	0.000	0.025	0.027	0.798	0.081	0.948	0.124
WAZ latent means	-0.001	0.358	0.428	0.795	1.144	0.946	1.750

Table 30: Model:Univariate IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.010	0.010	0.010	1.000	0.096	1.000	0.148
beta[2]	-0.016	0.052	0.059	0.827	0.183	0.971	0.282
sigma[1]	0.067	0.067	0.359	0.000	0.069	0.000	0.106
sigma[2]	-0.078	0.101	0.403	0.558	0.197	0.791	0.289
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.000	0.025	0.027	0.807	0.082	0.953	0.126
WAZ latent means	-0.001	0.169	0.205	0.691	0.447	0.907	0.761

Table 31: Model:Univariate BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.010	0.010	0.010	1.000	0.049	1.000	0.081
beta[2]	-0.016	0.052	0.059	0.813	0.179	0.967	0.274
sigma[1]	0.064	0.064	0.344	0.000	0.074	0.000	0.114
sigma[2]	-0.074	0.094	0.377	0.664	0.207	0.852	0.318
rho[1]	-0.105	0.105	0.121	0.990	0.464	0.996	0.655
rho[2]	-0.427	0.427	0.469	0.086	0.699	0.859	0.865
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.000	0.025	0.027	0.806	0.082	0.953	0.125
WAZ latent means	-0.001	0.168	0.204	0.744	0.495	0.934	0.818

Table 32: Model:Bivariate nonshared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.010	0.010	0.010	1.000	0.094	1.000	0.145
beta[2]	-0.016	0.052	0.059	0.823	0.181	0.970	0.279
sigma[1]	0.062	0.062	0.334	0.000	0.067	0.000	0.103
sigma[2]	-0.092	0.107	0.431	0.516	0.191	0.740	0.281

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.000	0.018	0.019	0.792	0.058	0.946	0.088
WAZ latent means	-0.001	0.171	0.207	0.661	0.423	0.892	0.726

Table 33: Model:Bivariate nonshared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.010	0.010	0.010	0.997	0.047	1.000	0.078
beta[2]	-0.016	0.052	0.059	0.809	0.177	0.966	0.271
sigma[1]	0.057	0.057	0.309	0.000	0.071	0.000	0.109
sigma[2]	-0.093	0.105	0.420	0.593	0.196	0.774	0.301
rho[1]	-0.096	0.096	0.112	0.976	0.446	0.987	0.634
rho[2]	-0.396	0.396	0.435	0.171	0.685	0.902	0.851
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.000	0.018	0.019	0.798	0.058	0.949	0.090
WAZ latent means	-0.001	0.170	0.206	0.709	0.466	0.916	0.774

Table 34: Model:Bivariate shared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.010	0.010	0.010	1.000	0.097	1.000	0.149
beta[2]	-0.016	0.052	0.059	0.834	0.189	0.972	0.290
sigma[1]	0.019	0.041	0.222	0.470	0.085	0.699	0.128
sigma[2]	-0.052	0.077	0.309	0.580	0.165	0.776	0.244
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	-0.173	0.393	0.500	0.587	0.921	0.810	1.411
HAZ latent means	0.000	0.018	0.019	0.815	0.059	0.955	0.091
WAZ latent means	-0.001	0.162	0.195	0.737	0.478	0.927	0.779

Table 35: Model:Bivariate shared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.010	0.010	0.010	1.000	0.051	1.000	0.083
beta[2]	-0.016	0.052	0.059	0.812	0.177	0.965	0.271
sigma[1]	0.010	0.044	0.235	0.482	0.088	0.725	0.134

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
sigma[2]	-0.049	0.074	0.299	0.630	0.177	0.830	0.269
rho[1]	-0.133	0.133	0.154	0.805	0.450	0.874	0.635
rho[2]	-0.363	0.363	0.398	0.201	0.591	0.732	0.760
lambda	-0.174	0.394	0.502	0.535	0.970	0.748	1.454
HAZ latent means	0.000	0.018	0.019	0.808	0.059	0.953	0.090
WAZ latent means	-0.001	0.160	0.193	0.712	0.446	0.911	0.732

Table 36: Model:Direct estimates

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	0	0.074	0.078	0.798	0.239	0.948	0.365
WAZ latent means	0	0.067	0.086	0.797	0.215	0.947	0.328

Table 37: Model:Univariate IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.015	0.017	0.017	0.977	0.082	1.000	0.127
beta[2]	-0.019	0.019	0.022	0.999	0.112	1.000	0.174
sigma[1]	0.006	0.012	0.062	0.969	0.064	1.000	0.099
sigma[2]	-0.007	0.012	0.041	0.996	0.084	1.000	0.129
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.002	0.065	0.068	0.803	0.213	0.950	0.326
WAZ latent means	-0.001	0.064	0.083	0.795	0.206	0.947	0.314

Table 38: Model:Univariate BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.015	0.017	0.017	0.952	0.075	1.000	0.117
beta[2]	-0.018	0.018	0.021	0.994	0.096	1.000	0.151
sigma[1]	0.010	0.014	0.072	0.945	0.068	0.998	0.105
sigma[2]	-0.005	0.011	0.038	1.000	0.088	1.000	0.136
rho[1]	0.171	0.171	Inf	0.000	0.468	0.000	0.678
rho[2]	0.243	0.243	Inf	0.000	0.509	0.000	0.711
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.002	0.066	0.069	0.799	0.214	0.949	0.327

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
WAZ latent means	0.000	0.064	0.083	0.794	0.205	0.946	0.314

Table 39: Model:Bivariate nonshared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.016	0.017	0.017	0.964	0.078	1.000	0.121
beta[2]	-0.021	0.021	0.025	0.996	0.107	1.000	0.165
sigma[1]	-0.006	0.012	0.061	0.966	0.061	0.998	0.094
sigma[2]	-0.023	0.023	0.080	0.925	0.079	1.000	0.122
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.003	0.067	0.071	0.776	0.206	0.932	0.315
WAZ latent means	-0.004	0.064	0.084	0.771	0.192	0.931	0.294

Table 40: Model:Bivariate nonshared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.015	0.017	0.017	0.946	0.072	1.000	0.111
beta[2]	-0.020	0.021	0.024	0.988	0.092	1.000	0.143
sigma[1]	-0.002	0.011	0.057	0.981	0.065	0.999	0.100
sigma[2]	-0.020	0.021	0.071	0.954	0.083	1.000	0.129
rho[1]	0.168	0.168	Inf	0.000	0.467	0.000	0.678
rho[2]	0.240	0.240	Inf	0.000	0.504	0.000	0.705
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.002	0.068	0.071	0.771	0.207	0.931	0.316
WAZ latent means	-0.003	0.065	0.085	0.769	0.192	0.930	0.294

Table 41: Model:Bivariate shared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.015	0.017	0.017	0.977	0.083	1.000	0.128
beta[2]	-0.020	0.020	0.023	0.999	0.111	1.000	0.172
sigma[1]	-0.029	0.029	0.151	0.474	0.051	0.902	0.079
sigma[2]	-0.009	0.012	0.043	0.994	0.084	1.000	0.129
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	-0.067	0.070	0.155	0.895	0.246	0.997	0.377

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	-0.002	0.065	0.069	0.800	0.212	0.949	0.325
WAZ latent means	-0.002	0.063	0.081	0.796	0.200	0.946	0.305

Table 42: Model:Bivariate shared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.015	0.017	0.017	0.956	0.075	1.000	0.117
beta[2]	-0.019	0.020	0.023	0.992	0.096	1.000	0.151
sigma[1]	-0.025	0.025	0.132	0.653	0.054	0.955	0.083
sigma[2]	-0.006	0.012	0.040	0.994	0.085	1.000	0.131
rho[1]	0.167	0.167	Inf	0.000	0.438	0.000	0.641
rho[2]	0.229	0.229	Inf	0.000	0.492	0.000	0.695
lambda	-0.059	0.063	0.140	0.927	0.248	0.993	0.380
HAZ latent means	-0.002	0.066	0.069	0.797	0.213	0.947	0.326
WAZ latent means	-0.002	0.063	0.081	0.793	0.200	0.945	0.306

Table 43: Model:Direct estimates

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	0	0.075	0.079	0.798	0.239	0.948	0.365
WAZ latent means	0	0.067	0.081	0.797	0.215	0.947	0.328

Table 44: Model:Univariate IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.002	0.011	0.011	0.999	0.085	1.000	0.132
beta[2]	-0.008	0.012	0.013	0.997	0.087	1.000	0.135
sigma[1]	-0.016	0.018	0.081	0.910	0.067	0.996	0.103
sigma[2]	-0.014	0.016	0.069	0.946	0.067	1.000	0.104
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.001	0.068	0.073	0.794	0.215	0.948	0.329
WAZ latent means	0.001	0.063	0.076	0.796	0.199	0.946	0.304

Table 45: Model:Univariate BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	0.000	0.010	0.011	0.971	0.057	0.999	0.091
beta[2]	-0.010	0.013	0.015	0.957	0.062	0.999	0.099
sigma[1]	-0.013	0.016	0.071	0.961	0.073	1.000	0.113
sigma[2]	-0.021	0.021	0.093	0.884	0.071	0.998	0.110
rho[1]	0.188	0.191	0.386	0.958	0.584	1.000	0.774
rho[2]	-0.392	0.392	0.423	0.007	0.588	0.371	0.773
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.001	0.066	0.070	0.800	0.211	0.951	0.323
WAZ latent means	-0.001	0.061	0.075	0.796	0.196	0.947	0.300

Table 46: Model:Bivariate nonshared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.002	0.010	0.010	0.999	0.086	1.000	0.133
beta[2]	-0.009	0.012	0.014	0.997	0.088	1.000	0.136
sigma[1]	-0.015	0.017	0.075	0.931	0.066	0.998	0.103
sigma[2]	-0.012	0.014	0.059	0.974	0.067	1.000	0.103
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.001	0.065	0.070	0.796	0.208	0.949	0.318
WAZ latent means	0.000	0.060	0.073	0.793	0.190	0.948	0.290

Table 47: Model:Bivariate nonshared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.001	0.010	0.010	0.972	0.057	0.999	0.091
beta[2]	-0.010	0.013	0.014	0.962	0.062	0.999	0.099
sigma[1]	-0.012	0.015	0.066	0.970	0.073	0.999	0.113
sigma[2]	-0.019	0.020	0.087	0.921	0.070	1.000	0.108
rho[1]	0.199	0.200	0.404	0.953	0.577	1.000	0.768
rho[2]	-0.392	0.392	0.422	0.004	0.591	0.365	0.775
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.001	0.063	0.068	0.798	0.203	0.951	0.311
WAZ latent means	0.000	0.058	0.071	0.798	0.186	0.949	0.285

Table 48: Model:Bivariate shared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.002	0.010	0.011	0.999	0.087	1.000	0.135
beta[2]	-0.009	0.012	0.014	0.997	0.087	1.000	0.135
sigma[1]	-0.017	0.018	0.081	0.912	0.067	0.995	0.103
sigma[2]	-0.012	0.015	0.063	0.959	0.068	1.000	0.104
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	-0.022	0.070	Inf	0.983	0.431	1.000	0.661
HAZ latent means	-0.001	0.066	0.070	0.792	0.208	0.947	0.319
WAZ latent means	0.000	0.060	0.073	0.790	0.189	0.946	0.290

Table 49: Model:Bivariate shared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.002	0.010	0.011	0.977	0.058	0.999	0.092
beta[2]	-0.010	0.013	0.014	0.963	0.061	0.999	0.098
sigma[1]	-0.014	0.016	0.073	0.950	0.072	0.999	0.112
sigma[2]	-0.020	0.021	0.090	0.881	0.070	0.994	0.109
rho[1]	0.196	0.197	0.396	0.955	0.573	1.000	0.764
rho[2]	-0.392	0.392	0.422	0.005	0.590	0.342	0.775
lambda	-0.030	0.080	Inf	0.977	0.452	0.999	0.694
HAZ latent means	-0.001	0.064	0.068	0.795	0.203	0.949	0.311
WAZ latent means	-0.001	0.058	0.072	0.795	0.185	0.946	0.284

Table 50: Model:Direct estimates

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	0	0.075	0.078	0.798	0.239	0.948	0.365
WAZ latent means	0	0.067	0.099	0.797	0.215	0.947	0.328

Table 51: Model:Univariate IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.017	0.018	0.019	0.993	0.098	1.000	0.152
beta[2]	-0.020	0.021	0.024	1.000	0.132	1.000	0.205
sigma[1]	0.020	0.021	0.093	0.893	0.074	0.995	0.114
sigma[2]	0.063	0.063	0.226	0.033	0.096	0.546	0.148

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.001	0.068	0.072	0.804	0.221	0.952	0.338
WAZ latent means	-0.001	0.065	0.097	0.799	0.208	0.949	0.319

Table 52: Model:Univariate BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.017	0.018	0.018	0.987	0.093	1.000	0.144
beta[2]	-0.020	0.020	0.024	0.999	0.117	1.000	0.182
sigma[1]	0.025	0.025	0.113	0.804	0.077	0.992	0.119
sigma[2]	0.065	0.065	0.235	0.029	0.100	0.554	0.154
rho[1]	0.097	0.097	Inf	0.000	0.298	0.000	0.481
rho[2]	0.194	0.194	Inf	0.000	0.437	0.000	0.636
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.000	0.068	0.072	0.802	0.222	0.951	0.339
WAZ latent means	-0.001	0.065	0.097	0.798	0.208	0.949	0.319

Table 53: Model:Bivariate nonshared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.019	0.019	0.020	0.989	0.098	1.000	0.151
beta[2]	-0.021	0.021	0.024	1.000	0.131	1.000	0.203
sigma[1]	0.018	0.019	0.083	0.936	0.073	0.999	0.113
sigma[2]	0.060	0.060	0.215	0.034	0.095	0.632	0.146
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.002	0.067	0.071	0.800	0.217	0.950	0.332
WAZ latent means	-0.001	0.062	0.094	0.797	0.199	0.949	0.305

Table 54: Model:Bivariate nonshared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.018	0.019	0.019	0.986	0.093	1.000	0.144
beta[2]	-0.020	0.021	0.024	0.999	0.116	1.000	0.181
sigma[1]	0.023	0.023	0.104	0.860	0.076	0.997	0.118

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
sigma[2]	0.063	0.063	0.225	0.032	0.099	0.638	0.152
rho[1]	0.094	0.094	Inf	0.000	0.286	0.000	0.464
rho[2]	0.188	0.188	Inf	0.000	0.424	0.000	0.622
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.001	0.068	0.072	0.799	0.218	0.949	0.333
WAZ latent means	-0.001	0.062	0.094	0.797	0.200	0.948	0.306

Table 55: Model:Bivariate shared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.018	0.019	0.020	0.992	0.100	1.000	0.154
beta[2]	-0.021	0.021	0.024	1.000	0.131	1.000	0.203
sigma[1]	0.018	0.018	0.083	0.939	0.072	0.999	0.111
sigma[2]	0.062	0.062	0.222	0.038	0.096	0.585	0.148
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	0.074	0.076	Inf	0.942	0.296	0.999	0.454
HAZ latent means	-0.002	0.067	0.071	0.803	0.219	0.951	0.335
WAZ latent means	-0.001	0.062	0.094	0.799	0.201	0.950	0.307

Table 56: Model:Bivariate shared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.018	0.019	0.019	0.988	0.095	1.000	0.147
beta[2]	-0.020	0.021	0.024	0.999	0.117	1.000	0.182
sigma[1]	0.022	0.022	0.100	0.843	0.073	0.993	0.112
sigma[2]	0.064	0.064	0.231	0.029	0.097	0.547	0.149
rho[1]	0.091	0.091	Inf	0.000	0.283	0.000	0.461
rho[2]	0.187	0.187	Inf	0.000	0.416	0.000	0.611
lambda	0.072	0.076	Inf	0.944	0.299	0.996	0.458
HAZ latent means	-0.001	0.068	0.072	0.802	0.220	0.951	0.336
WAZ latent means	-0.001	0.062	0.094	0.799	0.201	0.949	0.308

Table 57: Model:Direct estimates

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	0	0.075	0.081	0.798	0.239	0.950	0.365

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
WAZ latent means	0	0.067	0.083	0.796	0.215	0.946	0.329

Table 58: Model:Univariate IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.024	0.024	0.024	0.967	0.098	1.000	0.152
beta[2]	0.005	0.010	0.012	0.997	0.086	1.000	0.133
sigma[1]	0.001	0.011	0.046	0.995	0.075	1.000	0.115
sigma[2]	-0.040	0.040	0.159	0.401	0.066	0.866	0.102
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.006	0.069	0.076	0.798	0.221	0.951	0.338
WAZ latent means	0.000	0.063	0.078	0.793	0.198	0.946	0.303

Table 59: Model:Univariate BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.023	0.023	0.023	0.894	0.080	0.999	0.127
beta[2]	0.005	0.011	0.012	0.989	0.068	1.000	0.107
sigma[1]	0.007	0.012	0.052	0.993	0.082	1.000	0.126
sigma[2]	-0.038	0.038	0.151	0.546	0.071	0.946	0.110
rho[1]	-0.071	0.094	0.222	0.998	0.604	1.000	0.792
rho[2]	-0.510	0.510	0.559	0.001	0.599	0.138	0.786
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.005	0.068	0.075	0.800	0.221	0.951	0.338
WAZ latent means	0.000	0.062	0.078	0.794	0.198	0.946	0.302

Table 60: Model:Bivariate nonshared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.024	0.024	0.024	0.969	0.098	1.000	0.152
beta[2]	0.005	0.010	0.012	0.997	0.086	1.000	0.133
sigma[1]	0.001	0.011	0.046	0.995	0.075	1.000	0.115
sigma[2]	-0.040	0.040	0.159	0.398	0.066	0.866	0.102
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	-0.006	0.069	0.076	0.798	0.221	0.950	0.338
WAZ latent means	0.000	0.063	0.078	0.793	0.198	0.946	0.303

Table 61: Model:Bivariate nonshared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.023	0.023	0.023	0.893	0.080	0.999	0.127
beta[2]	0.005	0.011	0.012	0.990	0.068	1.000	0.107
sigma[1]	0.007	0.012	0.052	0.993	0.082	1.000	0.126
sigma[2]	-0.038	0.038	0.151	0.544	0.071	0.945	0.110
rho[1]	-0.071	0.094	0.222	0.998	0.604	1.000	0.792
rho[2]	-0.511	0.511	0.559	0.001	0.599	0.135	0.786
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	-0.005	0.068	0.075	0.799	0.221	0.951	0.337
WAZ latent means	0.000	0.062	0.078	0.794	0.197	0.945	0.302

Table 62: Model:Bivariate shared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.024	0.024	0.024	0.972	0.100	1.000	0.154
beta[2]	0.005	0.011	0.012	0.997	0.085	1.000	0.132
sigma[1]	-0.001	0.011	0.046	0.995	0.074	1.000	0.115
sigma[2]	-0.040	0.040	0.159	0.393	0.066	0.863	0.102
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	0.116	0.126	Inf	0.912	0.500	0.995	0.764
HAZ latent means	-0.006	0.069	0.076	0.797	0.221	0.950	0.338
WAZ latent means	0.000	0.063	0.078	0.791	0.198	0.946	0.303

Table 63: Model:Bivariate shared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.023	0.023	0.023	0.905	0.082	0.999	0.129
beta[2]	0.006	0.011	0.012	0.990	0.068	1.000	0.107
sigma[1]	0.005	0.012	0.049	0.996	0.081	1.000	0.126
sigma[2]	-0.038	0.038	0.152	0.522	0.071	0.938	0.109
rho[1]	-0.082	0.100	0.238	0.998	0.602	1.000	0.791
rho[2]	-0.513	0.513	0.562	0.001	0.598	0.133	0.786

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
lambda	0.071	0.098	Inf	0.963	0.520	1.000	0.795
HAZ latent means	-0.005	0.068	0.075	0.799	0.221	0.951	0.338
WAZ latent means	0.000	0.063	0.078	0.792	0.197	0.945	0.302

Table 64: Model:Direct estimates

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
HAZ latent means	0	0.075	0.078	0.798	0.239	0.950	0.365
WAZ latent means	0	0.067	0.091	0.796	0.215	0.946	0.329

Table 65: Model:Univariate IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.014	0.016	0.016	0.997	0.095	1.000	0.148
beta[2]	0.034	0.034	0.040	0.959	0.112	1.000	0.173
sigma[1]	0.002	0.011	0.047	0.994	0.073	1.000	0.112
sigma[2]	-0.004	0.011	0.039	0.995	0.084	1.000	0.130
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.000	0.068	0.071	0.801	0.220	0.950	0.336
WAZ latent means	0.002	0.065	0.088	0.793	0.206	0.946	0.314

Table 66: Model:Univariate BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.015	0.016	0.017	0.986	0.088	1.000	0.137
beta[2]	0.035	0.035	0.040	0.881	0.099	0.999	0.155
sigma[1]	0.006	0.012	0.053	0.991	0.076	1.000	0.118
sigma[2]	-0.002	0.011	0.038	0.996	0.087	1.000	0.134
rho[1]	0.144	0.144	Inf	0.000	0.378	0.000	0.570
rho[2]	0.191	0.191	Inf	0.000	0.414	0.000	0.607
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.000	0.068	0.072	0.798	0.220	0.949	0.337
WAZ latent means	0.002	0.065	0.088	0.793	0.206	0.945	0.315

Table 67: Model:Bivariate nonshared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.014	0.016	0.016	0.997	0.095	1.000	0.148
beta[2]	0.034	0.034	0.040	0.958	0.112	1.000	0.173
sigma[1]	0.002	0.011	0.047	0.994	0.073	1.000	0.112
sigma[2]	-0.004	0.011	0.039	0.995	0.084	1.000	0.130
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.000	0.068	0.071	0.800	0.220	0.950	0.336
WAZ latent means	0.002	0.065	0.088	0.793	0.206	0.946	0.314

Table 68: Model:Bivariate nonshared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.015	0.016	0.017	0.986	0.088	1.000	0.137
beta[2]	0.035	0.035	0.040	0.880	0.099	0.999	0.155
sigma[1]	0.006	0.012	0.052	0.992	0.076	1.000	0.118
sigma[2]	-0.002	0.011	0.038	0.996	0.087	1.000	0.134
rho[1]	0.144	0.144	Inf	0.000	0.378	0.000	0.570
rho[2]	0.192	0.192	Inf	0.000	0.414	0.000	0.608
lambda	NA	NA	NA	NA	NA	NA	NA
HAZ latent means	0.000	0.068	0.072	0.798	0.220	0.949	0.337
WAZ latent means	0.002	0.065	0.088	0.793	0.206	0.945	0.315

Table 69: Model:Bivariate shared IID

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.014	0.016	0.016	0.997	0.097	1.000	0.150
beta[2]	0.034	0.034	0.040	0.954	0.111	1.000	0.172
sigma[1]	-0.010	0.014	0.060	0.959	0.071	0.999	0.109
sigma[2]	-0.004	0.011	0.039	0.995	0.084	1.000	0.130
rho[1]	NA	NA	NA	NA	NA	NA	NA
rho[2]	NA	NA	NA	NA	NA	NA	NA
lambda	0.251	0.251	Inf	0.116	0.343	0.556	0.523
HAZ latent means	0.000	0.068	0.072	0.799	0.219	0.950	0.335
WAZ latent means	0.002	0.065	0.089	0.792	0.205	0.944	0.313

Table 70: Model:Bivariate shared BYM

parameter	bias	abs bias	relative abs bias	80% coverage	80% width	95% coverage	95% width
beta[1]	-0.014	0.016	0.016	0.986	0.088	1.000	0.137
beta[2]	0.035	0.035	0.040	0.879	0.100	0.999	0.155
sigma[1]	-0.005	0.012	0.052	0.985	0.074	1.000	0.114
sigma[2]	-0.002	0.011	0.038	0.993	0.086	1.000	0.132
rho[1]	0.193	0.193	Inf	0.000	0.460	0.000	0.656
rho[2]	0.186	0.186	Inf	0.000	0.407	0.000	0.600
lambda	0.267	0.267	Inf	0.086	0.346	0.470	0.530
HAZ latent means	0.000	0.068	0.072	0.796	0.220	0.948	0.336
WAZ latent means	0.002	0.065	0.088	0.792	0.205	0.944	0.313