

## Two-level Moderated Mediation Models with Single Level Data and New Measures of Effect Sizes

### Supplementary Material A: Results of the Simulation Study

The material here includes the results of the conditional indirect effect ( $\gamma_{moME}$ ) given  $Z_1 = 1$  and  $Z_2 = 1$ , the difference between two conditional indirect effects ( $dif_{moME}$ ) under  $Z_1 = 1, Z_2 = 1$  versus  $Z_1 = -1, Z_2 = -1$ , and the seven proposed moderated mediation effect sizes ( $\varphi, \varphi_1, \varphi_2, \varphi_{12}, \varphi_1^{(f)}, \varphi_2^{(f)},$  and  $\varphi_{12}^{(f)}$ ) under different conditions in the simulation study, as described in the article.

**Table A1.** Empirical Bias, Mean Square Error (MSE), Coverage Rate of the 95% CI, and Rejection Rate in Estimating  $\gamma_{moME}$

	$\gamma_{a_1} = \gamma_{b_1}$	$\sigma_{ua}^2 = \sigma_{ub}^2 = \sigma_{uc}^2$	True $\gamma_{moME}$	moME					2moME				
				50	100	200	500	1000	50	100	200	500	1000
Bias	0	0	0.16	-0.007	0.001	-0.001	0.001	0.000	-0.003	0.002	0.005	0.002	-0.002
		0.1	0.16	-0.001	0.001	0.003	-0.001	0.002	0.002	0.000	0.007	0.000	-0.002
		0.25	0.16	-0.004	-0.003	0.004	-0.001	0.000	0.002	-0.004	0.006	0.000	0.000
		0.5	0.16	0.007	0.002	0.004	0.004	0.000	0.006	0.000	0.004	0.005	-0.001
	0.2	0	0.36	0.006	0.001	0.004	-0.001	0.002	0.009	0.005	0.013	0.000	-0.003
		0.1	0.36	-0.007	0.009	0.001	-0.002	0.002	-0.006	0.011	0.009	0.001	0.000
		0.25	0.36	-0.008	0.008	0.001	-0.002	0.001	-0.007	0.011	0.006	0.000	0.001
		0.5	0.36	0.018	-0.003	-0.002	0.004	0.002	0.021	-0.004	0.001	0.004	-0.002
	0.4	0	0.64	0.001	0.005	0.002	-0.002	0.002	0.004	0.008	0.015	-0.001	-0.002
		0.1	0.64	-0.009	0.013	0.001	-0.002	0.000	-0.009	0.015	0.012	0.001	0.000
		0.25	0.64	-0.009	-0.008	-0.009	-0.001	0.002	0.003	-0.001	0.001	0.004	-0.002
		0.5	0.64	0.009	0.009	0.019	0.004	0.000	0.009	0.000	0.018	0.003	0.001
MSE	0	0	0.16	0.018	0.008	0.004	0.001	0.001	0.020	0.008	0.004	0.001	0.001
		0.1	0.16	0.021	0.010	0.005	0.002	0.001	0.022	0.010	0.005	0.002	0.001
		0.25	0.16	0.027	0.013	0.007	0.002	0.001	0.026	0.011	0.006	0.002	0.001
		0.5	0.16	0.054	0.022	0.010	0.004	0.002	0.041	0.017	0.007	0.003	0.002
	0.2	0	0.36	0.041	0.015	0.008	0.003	0.001	0.045	0.017	0.009	0.003	0.001
		0.1	0.36	0.043	0.022	0.010	0.004	0.002	0.045	0.022	0.010	0.004	0.002
		0.25	0.36	0.058	0.030	0.014	0.006	0.003	0.055	0.027	0.013	0.005	0.002
		0.5	0.36	0.107	0.047	0.020	0.008	0.004	0.090	0.036	0.015	0.006	0.003
	0.4	0	0.64	0.061	0.026	0.012	0.005	0.003	0.072	0.028	0.014	0.005	0.003
		0.1	0.64	0.073	0.038	0.017	0.007	0.003	0.076	0.038	0.017	0.007	0.003
		0.25	0.64	0.100	0.052	0.023	0.010	0.005	0.096	0.046	0.020	0.008	0.004
		0.5	0.64	0.173	0.086	0.046	0.016	0.008	0.137	0.060	0.031	0.011	0.005

	$\gamma_{a_1} = \gamma_{b_1}$	$\sigma_{ua}^2 = \sigma_{ub}^2 = \sigma_{uc}^2$	True $\gamma_{moME}$	moME					2moME				
				50	100	200	500	1000	50	100	200	500	1000
Coverage Rate	0	0	0.16	0.965	0.941	0.936	0.942	0.944	0.987	0.965	0.959	0.951	0.949
		0.1	0.16	0.949	0.917	0.919	0.907	0.927	0.989	0.953	0.955	0.946	0.952
		0.25	0.16	0.944	0.909	0.893	0.874	0.908	0.995	0.958	0.948	0.947	0.945
		0.5	0.16	0.956	0.881	0.874	0.845	0.830	0.996	0.958	0.958	0.942	0.931
	0.2	0	0.36	0.953	0.954	0.950	0.954	0.951	0.971	0.972	0.958	0.958	0.953
		0.1	0.36	0.933	0.936	0.923	0.919	0.930	0.972	0.968	0.957	0.955	0.955
		0.25	0.36	0.920	0.916	0.886	0.891	0.902	0.967	0.966	0.957	0.955	0.955
		0.5	0.36	0.899	0.845	0.851	0.856	0.836	0.970	0.947	0.960	0.956	0.943
	0.4	0	0.64	0.957	0.958	0.961	0.939	0.948	0.975	0.970	0.973	0.950	0.953
		0.1	0.64	0.928	0.924	0.924	0.915	0.920	0.968	0.969	0.961	0.958	0.960
		0.25	0.64	0.926	0.879	0.898	0.885	0.866	0.978	0.950	0.959	0.953	0.942
		0.5	0.64	0.886	0.844	0.835	0.828	0.828	0.969	0.953	0.951	0.950	0.952
Rejection Rate	0	0	0.16	0.076	0.451	0.910	1.000	1.000	0.024	0.312	0.882	1.000	1.000
		0.1	0.16	0.061	0.388	0.854	1.000	1.000	0.021	0.220	0.788	1.000	1.000
		0.25	0.16	0.056	0.300	0.736	0.993	1.000	0.016	0.142	0.632	0.994	1.000
		0.5	0.16	0.056	0.234	0.613	0.971	0.999	0.008	0.104	0.448	0.971	1.000
	0.2	0	0.36	0.432	0.940	1.000	1.000	1.000	0.226	0.877	1.000	1.000	1.000
		0.1	0.36	0.341	0.873	0.999	1.000	1.000	0.136	0.777	0.996	1.000	1.000
		0.25	0.36	0.265	0.789	0.989	1.000	1.000	0.111	0.663	0.991	1.000	1.000
		0.5	0.36	0.231	0.604	0.951	1.000	1.000	0.099	0.456	0.935	1.000	1.000
	0.4	0	0.64	0.818	0.997	1.000	1.000	1.000	0.633	0.993	1.000	1.000	1.000
		0.1	0.64	0.739	0.992	1.000	1.000	1.000	0.541	0.984	1.000	1.000	1.000
		0.25	0.64	0.627	0.974	1.000	1.000	1.000	0.429	0.959	1.000	1.000	1.000
		0.5	0.64	0.482	0.912	0.997	1.000	1.000	0.279	0.851	1.000	1.000	1.000

**Table A2.** Empirical Bias, Mean Square Error (MSE), Coverage Rate of the 95% CI, and Rejection Rate in Estimating  $dif_{moME}$

	$\gamma_{a_1} = \gamma_{b_1}$	$\sigma_{ua}^2 = \sigma_{ub}^2 = \sigma_{uc}^2$	True $dif_{moME}$	moME					2moME					
				50	100	200	500	1000	50	100	200	500	1000	
Bias	0	0	0	-0.009	-0.001	-0.002	0.002	-0.001	-0.011	-0.001	-0.003	0.002	-0.001	
		0.1	0	-0.004	0.002	0.002	-0.001	0.000	-0.007	-0.001	0.001	-0.001	-0.001	
		0.25	0	-0.007	0.001	-0.001	-0.001	-0.001	-0.004	-0.003	-0.002	-0.001	-0.001	
		0.5	0	0.004	0.006	0.005	0.004	0.001	-0.001	-0.001	0.001	0.005	0.000	
	0.2	0	0.32	0.005	0.003	0.004	-0.001	0.000	0.005	0.006	0.010	-0.001	-0.002	
		0.1	0.32	-0.008	0.005	0.001	-0.002	0.002	-0.011	0.006	0.006	-0.001	0.001	
		0.25	0.32	-0.007	0.003	0.001	-0.003	0.002	-0.011	0.006	0.004	-0.001	0.002	
		0.5	0.32	0.015	-0.003	-0.003	0.005	0.000	0.015	-0.004	-0.002	0.004	-0.002	
	0.4	0	0.64	0.001	0.006	0.003	-0.002	0.002	0.003	0.008	0.016	-0.001	-0.002	
		0.1	0.64	-0.008	0.012	0.001	-0.002	0.002	-0.011	0.014	0.012	0.001	-0.001	
		0.25	0.64	-0.012	-0.006	-0.008	-0.001	0.000	-0.002	0.001	0.001	0.003	-0.002	
		0.5	0.64	0.002	0.008	0.017	0.004	0.002	0.001	0.000	0.018	0.003	0.001	
	MSE	0	0	0	0.038	0.015	0.007	0.002	0.001	0.042	0.016	0.007	0.002	0.001
			0.1	0	0.047	0.018	0.009	0.003	0.002	0.049	0.018	0.009	0.003	0.002
			0.25	0	0.061	0.026	0.013	0.004	0.002	0.059	0.024	0.012	0.004	0.002
			0.5	0	0.116	0.042	0.018	0.007	0.004	0.090	0.033	0.014	0.005	0.003
0.2		0	0.32	0.047	0.017	0.009	0.003	0.002	0.052	0.018	0.010	0.003	0.002	
		0.1	0.32	0.052	0.025	0.011	0.004	0.002	0.055	0.024	0.011	0.004	0.002	
		0.25	0.32	0.072	0.035	0.015	0.006	0.003	0.068	0.030	0.014	0.005	0.003	
		0.5	0.32	0.128	0.052	0.024	0.009	0.005	0.110	0.040	0.017	0.006	0.003	
0.4		0	0.64	0.063	0.026	0.013	0.005	0.003	0.075	0.029	0.014	0.005	0.003	
		0.1	0.64	0.078	0.039	0.018	0.007	0.003	0.081	0.039	0.018	0.007	0.003	
		0.25	0.64	0.108	0.054	0.023	0.010	0.005	0.103	0.048	0.021	0.008	0.004	
		0.5	0.64	0.189	0.090	0.046	0.016	0.008	0.148	0.062	0.031	0.011	0.005	

	$\gamma_{a_1} = \gamma_{b_1}$	$\sigma_{ua}^2 = \sigma_{ub}^2 = \sigma_{uc}^2$	True $dif_{moME}$	moME					2moME					
				50	100	200	500	1000	50	100	200	500	1000	
Coverage Rate	0	0	0	0.981	0.968	0.957	0.954	0.941	0.988	0.982	0.969	0.964	0.952	
		0.1	0	0.980	0.966	0.946	0.924	<b>0.917</b>	1.000	0.984	0.978	0.958	0.947	
		0.25	0	0.980	0.941	<b>0.909</b>	<b>0.916</b>	<b>0.888</b>	0.996	0.980	0.965	0.955	0.956	
		0.5	0	0.956	0.921	<b>0.902</b>	<b>0.855</b>	<b>0.830</b>	0.994	0.981	0.971	0.963	0.948	
	0.2	0	0.32	0.961	0.970	0.950	0.963	0.942	0.982	0.983	0.965	0.969	0.951	
		0.1	0.32	0.962	0.943	0.932	0.920	0.921	0.987	0.980	0.963	0.949	0.949	
		0.25	0.32	0.949	0.922	<b>0.893</b>	<b>0.890</b>	<b>0.888</b>	0.990	0.981	0.970	0.957	0.949	
		0.5	0.32	0.932	<b>0.887</b>	<b>0.878</b>	<b>0.858</b>	<b>0.833</b>	0.990	0.973	0.965	0.959	0.949	
	0.4	0	0.64	0.960	0.960	0.960	0.940	0.948	0.981	0.976	0.970	0.950	0.951	
		0.1	0.64	0.946	0.930	0.922	<b>0.919</b>	0.923	0.982	0.976	0.962	0.960	0.960	
		0.25	0.64	0.936	<b>0.880</b>	<b>0.906</b>	<b>0.889</b>	<b>0.873</b>	0.980	0.955	0.961	0.954	0.949	
		0.5	0.64	<b>0.912</b>	<b>0.860</b>	<b>0.844</b>	<b>0.836</b>	<b>0.833</b>	0.984	0.964	0.955	0.953	0.956	
	Rejection Rate	0	0	0	0.019	0.032	0.043	0.046	0.059	0.012	0.018	0.031	0.036	0.048
			0.1	0	0.020	0.034	0.054	0.076	<b>0.083</b>	0.000	0.016	0.022	0.042	0.053
			0.25	0	0.020	0.059	<b>0.091</b>	<b>0.084</b>	<b>0.112</b>	0.004	0.020	0.035	0.045	0.044
			0.5	0	0.044	0.079	<b>0.098</b>	<b>0.145</b>	<b>0.170</b>	0.006	0.019	0.029	0.037	0.052
0.2		0	0.32	0.248	0.721	0.972	1.000	1.000	0.097	0.607	0.953	1.000	1.000	
		0.1	0.32	0.178	0.620	0.941	1.000	1.000	0.077	0.489	0.909	1.000	1.000	
		0.25	0.32	0.149	0.518	0.887	0.999	1.000	0.050	0.366	0.831	0.999	1.000	
		0.5	0.32	0.154	0.414	0.762	0.993	1.000	0.052	0.255	0.668	0.992	1.000	
0.4		0	0.64	0.727	0.996	1.000	1.000	1.000	0.517	0.987	1.000	1.000	1.000	
		0.1	0.64	0.647	0.986	1.000	1.000	1.000	0.396	0.970	1.000	1.000	1.000	
		0.25	0.64	0.513	0.949	1.000	1.000	1.000	0.304	0.911	0.999	1.000	1.000	
		0.5	0.64	0.370	0.848	0.995	1.000	1.000	0.189	0.775	0.996	1.000	1.000	

**Table A3.** Empirical Bias, Mean Square Error (MSE), and Coverage Rate of the 95% CI in Estimating  $\varphi_1^{(f)}$

	$\gamma_{a_1} = \gamma_{b_1}$	$\sigma_{ua}^2 = \sigma_{ub}^2 = \sigma_{uc}^2$	True $\varphi_1^{(f)}$	moME					2moME				
				50	100	200	500	1000	50	100	200	500	1000
Bias	0.2	0	0.348	0.063	0.046	0.025	0.020	0.006	0.064	0.057	0.034	0.014	0.004
		0.1	0.348	0.064	0.053	0.036	0.020	0.008	0.065	0.057	0.044	0.015	0.006
		0.25	0.348	0.061	0.057	0.044	0.024	0.012	0.063	0.060	0.052	0.017	0.007
		0.5	0.348	0.054	0.070	0.066	0.027	0.015	0.047	0.072	0.073	0.017	0.008
	0.4	0	0.271	0.030	0.014	0.008	0.001	0.001	0.040	0.022	0.014	-0.003	-0.001
		0.1	0.271	0.052	0.021	0.011	0.008	0.002	0.061	0.026	0.017	0.005	0.001
		0.25	0.271	0.061	0.039	0.016	0.009	0.003	0.066	0.040	0.021	0.005	0.003
		0.5	0.271	0.073	0.057	0.024	0.012	0.003	0.072	0.056	0.029	0.007	0.002
MSE	0.2	0	0.348	0.040	0.038	0.031	0.015	0.007	0.035	0.037	0.030	0.014	0.007
		0.1	0.348	0.046	0.046	0.037	0.018	0.009	0.036	0.041	0.034	0.017	0.008
		0.25	0.348	0.049	0.052	0.046	0.026	0.013	0.036	0.043	0.038	0.022	0.010
		0.5	0.348	0.046	0.055	0.059	0.037	0.020	0.032	0.042	0.046	0.026	0.014
	0.4	0	0.271	0.032	0.018	0.009	0.004	0.002	0.030	0.019	0.009	0.004	0.002
		0.1	0.271	0.038	0.024	0.012	0.005	0.002	0.034	0.024	0.012	0.005	0.002
		0.25	0.271	0.045	0.034	0.019	0.007	0.004	0.037	0.028	0.016	0.006	0.003
		0.5	0.271	0.049	0.046	0.026	0.013	0.006	0.038	0.034	0.019	0.008	0.004
Coverage Rate	0.2	0	0.348	0.972	0.938	0.905	0.928	0.939	0.986	0.967	0.944	0.953	0.949
		0.1	0.348	0.958	0.916	0.901	0.910	0.928	0.984	0.977	0.963	0.943	0.952
		0.25	0.348	0.942	0.900	0.858	0.874	0.889	0.984	0.949	0.943	0.938	0.954
		0.5	0.348	0.949	0.898	0.842	0.813	0.833	0.989	0.969	0.934	0.929	0.938
	0.4	0	0.271	0.923	0.934	0.945	0.943	0.951	0.961	0.945	0.967	0.946	0.947
		0.1	0.271	0.908	0.891	0.910	0.919	0.930	0.957	0.920	0.944	0.942	0.957
		0.25	0.271	0.900	0.873	0.857	0.890	0.876	0.968	0.941	0.933	0.949	0.938
		0.5	0.271	0.894	0.838	0.833	0.813	0.819	0.956	0.939	0.940	0.930	0.945

**Table A4.** Empirical Bias, Mean Square Error (MSE), and Coverage Rate of the 95% CI in Estimating  $\varphi_2^{(f)}$

	$\gamma_{a_1} = \gamma_{b_1}$	$\sigma_{ua}^2 = \sigma_{ub}^2 = \sigma_{uc}^2$	True $\varphi_2^{(f)}$	moME					2moME					
				50	100	200	500	1000	50	100	200	500	1000	
Bias	0.2	0	0.348	0.073	0.054	0.035	0.004	0.006	0.069	0.052	0.035	0.011	0.008	
		0.1	0.348	0.075	0.066	0.033	0.010	0.005	0.069	0.068	0.033	0.017	0.008	
		0.25	0.348	0.076	0.073	0.042	0.015	0.005	0.068	0.073	0.039	0.023	0.010	
		0.5	0.348	0.068	0.060	0.044	0.024	0.011	0.067	0.057	0.041	0.032	0.017	
	0.4	0	0.271	0.061	0.033	0.012	0.005	0.003	0.069	0.034	0.015	0.010	0.004	
		0.1	0.271	0.056	0.035	0.013	0.004	0.002	0.060	0.039	0.014	0.009	0.002	
		0.25	0.271	0.053	0.025	0.021	0.004	0.002	0.055	0.029	0.020	0.008	0.002	
		0.5	0.271	0.060	0.029	0.012	0.005	0.007	0.066	0.033	0.015	0.010	0.007	
	MSE	0.2	0	0.348	0.044	0.040	0.033	0.015	0.007	0.037	0.037	0.032	0.015	0.007
			0.1	0.348	0.048	0.048	0.037	0.018	0.009	0.037	0.043	0.033	0.018	0.008
			0.25	0.348	0.052	0.053	0.045	0.024	0.012	0.037	0.045	0.037	0.022	0.010
			0.5	0.348	0.047	0.052	0.053	0.036	0.019	0.035	0.039	0.040	0.029	0.014
0.4		0	0.271	0.036	0.020	0.010	0.004	0.002	0.034	0.021	0.010	0.004	0.002	
		0.1	0.271	0.039	0.025	0.013	0.005	0.002	0.034	0.025	0.012	0.005	0.002	
		0.25	0.271	0.042	0.030	0.019	0.006	0.003	0.034	0.026	0.017	0.006	0.003	
		0.5	0.271	0.046	0.038	0.023	0.010	0.005	0.036	0.030	0.019	0.008	0.004	
Coverage Rate		0.2	0	0.348	0.970	0.937	0.906	0.921	0.942	0.986	0.962	0.936	0.938	0.949
			0.1	0.348	0.954	<b>0.915</b>	<b>0.888</b>	<b>0.901</b>	<b>0.912</b>	0.986	0.960	0.938	0.934	0.952
			0.25	0.348	0.944	<b>0.905</b>	<b>0.867</b>	<b>0.875</b>	<b>0.887</b>	0.984	0.955	0.939	0.933	0.951
			0.5	0.348	0.951	<b>0.902</b>	<b>0.845</b>	<b>0.815</b>	<b>0.829</b>	0.984	0.963	0.933	0.936	0.947
	0.4	0	0.271	0.930	0.929	0.928	0.943	0.946	0.956	0.949	0.945	0.947	0.955	
		0.1	0.271	<b>0.918</b>	<b>0.902</b>	<b>0.905</b>	<b>0.918</b>	0.927	0.967	0.931	0.937	0.946	0.952	
		0.25	0.271	<b>0.888</b>	<b>0.866</b>	<b>0.859</b>	<b>0.913</b>	<b>0.899</b>	0.959	0.932	0.927	0.952	0.951	
		0.5	0.271	<b>0.894</b>	<b>0.842</b>	<b>0.832</b>	<b>0.852</b>	<b>0.863</b>	0.958	0.926	0.918	0.940	0.955	

**Table A5.** Empirical Bias, Mean Square Error (MSE), and Coverage Rate of the 95% CI in Estimating  $\varphi_{12}^{(f)}$

	$\gamma_{a_1} = \gamma_{b_1}$	$\sigma_{ua}^2 = \sigma_{ub}^2 = \sigma_{uc}^2$	True $\varphi_{12}^{(f)}$	moME					2moME					
				50	100	200	500	1000	50	100	200	500	1000	
Bias	0.2	0	0.095	0.040	0.009	-0.004	-0.005	-0.003	0.055	0.012	-0.007	-0.006	-0.002	
		0.1	0.095	0.047	0.010	-0.003	-0.007	-0.002	0.063	0.014	-0.005	-0.007	-0.001	
		0.25	0.095	0.061	0.018	-0.001	-0.007	-0.003	0.074	0.023	-0.002	-0.007	-0.002	
		0.5	0.095	0.085	0.042	0.006	-0.005	-0.005	0.094	0.043	0.002	-0.005	-0.005	
	0.4	0	0.295	-0.016	-0.017	-0.005	0.001	-0.001	-0.018	-0.021	-0.014	0.000	0.001	
		0.1	0.295	-0.022	-0.018	-0.006	-0.006	-0.001	-0.020	-0.021	-0.013	-0.007	0.001	
		0.25	0.295	-0.010	-0.011	-0.013	-0.004	0.000	-0.009	-0.014	-0.018	-0.004	0.001	
		0.5	0.295	-0.011	-0.015	-0.002	-0.003	-0.004	-0.010	-0.020	-0.013	-0.004	-0.003	
	MSE	0.2	0	0.095	0.009	0.005	0.002	0.001	0.000	0.010	0.004	0.002	0.001	0.000
			0.1	0.095	0.012	0.006	0.003	0.001	0.001	0.012	0.006	0.003	0.001	0.001
			0.25	0.095	0.016	0.008	0.004	0.002	0.001	0.015	0.007	0.003	0.002	0.001
			0.5	0.095	0.023	0.013	0.007	0.003	0.001	0.020	0.011	0.004	0.002	0.001
0.4		0	0.295	0.018	0.010	0.005	0.002	0.001	0.017	0.011	0.005	0.002	0.001	
		0.1	0.295	0.021	0.015	0.008	0.003	0.001	0.018	0.015	0.007	0.003	0.001	
		0.25	0.295	0.026	0.018	0.011	0.004	0.002	0.020	0.015	0.009	0.003	0.002	
		0.5	0.295	0.030	0.025	0.016	0.006	0.003	0.022	0.018	0.012	0.004	0.002	
Coverage Rate		0.2	0	0.095	0.991	0.954	0.899	0.915	0.935	0.997	0.975	0.936	0.930	0.944
			0.1	0.095	0.990	0.937	0.891	0.891	0.904	0.997	0.973	0.937	0.935	0.943
			0.25	0.095	0.985	0.942	0.879	0.857	0.883	0.997	0.983	0.935	0.936	0.941
			0.5	0.095	0.979	0.958	0.873	0.801	0.828	0.995	0.988	0.946	0.943	0.944
	0.4	0	0.295	0.921	0.922	0.946	0.947	0.955	0.954	0.949	0.950	0.953	0.955	
		0.1	0.295	0.901	0.879	0.909	0.925	0.927	0.952	0.922	0.938	0.955	0.952	
		0.25	0.295	0.885	0.886	0.871	0.898	0.890	0.956	0.949	0.937	0.962	0.951	
		0.5	0.295	0.868	0.836	0.851	0.860	0.848	0.957	0.944	0.942	0.963	0.938	

**Table A6.** Empirical Bias, Mean Square Error (MSE), and Coverage Rate of the 95% CI in Estimating  $\varphi$  with the 2moME Model

	$\gamma_{a_1} = \gamma_{b_1}$	$\sigma_{ua}^2 = \sigma_{ub}^2 = \sigma_{uc}^2$	True $\varphi$	50	100	200	500	1000
<b>Bias</b>								
	0	0.1	0	0.072	0.069	0.052	0.021	0.010
		0.25	0	0.087	0.067	0.036	0.015	0.007
		0.5	0	0.051	0.040	0.019	0.007	0.003
	0.2	0.1	0.2688	-0.097	-0.068	-0.036	0.005	0.010
		0.25	0.1016	0.032	0.028	0.021	0.014	0.007
		0.5	0.0393	0.068	0.035	0.017	0.008	0.003
	0.4	0.1	0.5607	-0.099	-0.069	-0.091	-0.019	-0.007
		0.25	0.2980	-0.067	-0.034	-0.004	0.004	0.005
		0.5	0.1422	0.021	0.016	0.015	0.007	0.003
<b>MSE</b>								
	0	0.1	0	0.010	0.008	0.005	0.001	0.000
		0.25	0	0.008	0.005	0.004	0.001	0.000
		0.5	0	0.007	0.003	0.001	0.001	0.000
	0.2	0.1	0.2688	0.017	0.015	0.012	0.010	0.006
		0.25	0.1016	0.007	0.007	0.005	0.003	0.001
		0.5	0.0393	0.010	0.004	0.002	0.001	0.000
	0.4	0.1	0.5607	0.086	0.043	0.020	0.010	0.006
		0.25	0.2980	0.016	0.013	0.009	0.005	0.003
		0.5	0.1422	0.009	0.008	0.005	0.002	0.001
<b>Coverage Rate</b>								
	0	0.1	0	-	-	-	-	-
		0.25	0	-	-	-	-	-
		0.5	0	-	-	-	-	-
	0.2	0.1	0.2688	0.983	0.975	0.924	0.93	0.947
		0.25	0.1016	0.988	0.971	0.949	0.937	0.952
		0.5	0.0393	0.994	0.993	0.971	0.956	0.954
	0.4	0.1	0.5607	0.923	0.916	0.922	0.936	0.945
		0.25	0.2980	0.927	0.928	0.952	0.938	0.944
		0.5	0.1422	0.966	0.933	0.944	0.937	0.947

**Table A7.** Empirical Bias, Mean Square Error (MSE), and Coverage Rate of the 95% CI in Estimating  $\varphi_1$  with the 2moME Model

	$\gamma_{a_1} = \gamma_{b_1}$	$\sigma_{ua}^2 = \sigma_{ub}^2 = \sigma_{uc}^2$	True $\varphi_1$	50	100	200	500	1000
Bias								
0	0	0.1	0	-0.029	-0.018	-0.006	0.004	0.004
		0.25	0	0.016	0.014	0.012	0.007	0.003
		0.5	0	0.023	0.014	0.008	0.003	0.001
	0.2	0.1	0.0936	-0.030	-0.018	-0.009	-0.003	-0.002
		0.25	0.0354	-0.010	-0.002	0.002	0.002	0.002
		0.5	0.0137	0.011	0.010	0.007	0.002	0.000
	0.4	0.1	0.1520	-0.029	-0.018	-0.006	0.004	0.004
		0.25	0.0808	0.016	0.014	0.012	0.007	0.003
		0.5	0.0385	0.023	0.014	0.008	0.003	0.001
MSE								
0	0	0.1	0	0.004	0.004	0.004	0.003	0.001
		0.25	0	0.002	0.002	0.002	0.001	0.000
		0.5	0	0.002	0.001	0.000	0.000	0.000
	0.2	0.1	0.2688	0.008	0.006	0.004	0.002	0.001
		0.25	0.1016	0.003	0.003	0.002	0.001	0.001
		0.5	0.0393	0.002	0.002	0.001	0.000	0.000
	0.4	0.1	0.5607	0.004	0.004	0.004	0.003	0.001
		0.25	0.2980	0.002	0.002	0.002	0.001	0.000
		0.5	0.1422	0.002	0.001	0.000	0.000	0.000
Coverage Rate								
0	0	0.1	0	-	-	-	-	-
		0.25	0	-	-	-	-	-
		0.5	0	-	-	-	-	-
	0.2	0.1	0.2688	0.890	0.906	0.925	0.934	0.942
		0.25	0.1016	0.971	0.940	0.910	0.920	0.936
		0.5	0.0393	0.990	0.972	0.944	0.936	0.942
	0.4	0.1	0.5607	0.889	0.903	0.919	0.928	0.941
		0.25	0.2980	0.900	0.913	0.923	0.936	0.952
		0.5	0.1422	0.934	0.928	0.921	0.936	0.944

**Table A8.** Empirical Bias, Mean Square Error (MSE), and Coverage Rate of the 95% CI in Estimating  $\varphi_2$  with the 2moME Model

	$\gamma_{a_1} = \gamma_{b_1}$	$\sigma_{ua}^2 = \sigma_{ub}^2 = \sigma_{uc}^2$	True $\varphi_2$	50	100	200	500	1000
Bias								
0	0	0.1	0	-0.031	-0.020	-0.007	0.005	0.004
		0.25	0	0.018	0.015	0.012	0.007	0.004
		0.5	0	0.026	0.019	0.009	0.003	0.002
	0.2	0.1	0.0936	-0.029	-0.017	-0.011	-0.005	0.003
		0.25	0.0354	-0.020	-0.012	0.009	0.004	0.002
		0.5	0.0137	0.018	0.013	0.010	0.007	0.001
	0.4	0.1	0.1520	-0.031	-0.017	-0.011	-0.001	-0.001
		0.25	0.0808	-0.011	0.006	0.003	0.003	0.001
		0.5	0.0385	0.012	0.006	0.004	0.002	0.001
MSE								
0	0	0.1	0	0.005	0.004	0.003	0.003	0.001
		0.25	0	0.003	0.002	0.002	0.001	0.000
		0.5	0	0.002	0.001	0.000	0.000	0.000
	0.2	0.1	0.2688	0.007	0.006	0.004	0.002	0.001
		0.25	0.1016	0.004	0.003	0.002	0.001	0.001
		0.5	0.0393	0.002	0.002	0.002	0.001	0.000
	0.4	0.1	0.5607	0.004	0.004	0.003	0.003	0.001
		0.25	0.2980	0.003	0.002	0.001	0.001	0.000
		0.5	0.1422	0.002	0.001	0.000	0.000	0.000
Coverage Rate								
0	0	0.1	0	-	-	-	-	-
		0.25	0	-	-	-	-	-
		0.5	0	-	-	-	-	-
	0.2	0.1	0.2688	0.887	0.910	0.927	0.932	0.944
		0.25	0.1016	0.976	0.931	0.915	0.930	0.946
		0.5	0.0393	0.985	0.969	0.934	0.937	0.947
	0.4	0.1	0.5607	0.893	0.923	0.929	0.938	0.945
		0.25	0.2980	0.902	0.917	0.933	0.939	0.954
		0.5	0.1422	0.914	0.920	0.931	0.946	0.954

**Table A9.** Empirical Bias, Mean Square Error (MSE), and Coverage Rate of the 95% CI in Estimating  $\varphi_{12}$  with the 2moME Model

	$\gamma_{a_1} = \gamma_{b_1}$	$\sigma_{ua}^2 = \sigma_{ub}^2 = \sigma_{uc}^2$	True $\varphi_{12}$	50	100	200	500	1000
<b>Bias</b>								
0	0.1	0.1	0	0.002	0.001	0.000	0.000	0.000
		0.25	0	0.003	0.002	0.000	0.000	0.000
		0.5	0	0.003	0.002	0.001	0.001	0.000
	0.2	0.1	0.0255	0.005	0.001	-0.000	0.001	0.002
		0.25	0.0096	0.010	0.008	0.004	0.002	0.001
		0.5	0.0037	0.015	0.008	0.003	0.001	0.000
	0.4	0.1	0.1656	-0.037	-0.025	-0.015	-0.004	-0.001
		0.25	0.0880	-0.001	-0.008	-0.003	0.001	0.002
		0.5	0.0420	0.011	0.006	0.003	0.002	0.001
<b>MSE</b>								
0	0.1	0.1	0	0.002	0.000	0.000	0.000	0.000
		0.25	0	0.001	0.000	0.000	0.000	0.000
		0.5	0	0.001	0.000	0.000	0.000	0.000
	0.2	0.1	0.0255	0.001	0.001	0.000	0.000	0.000
		0.25	0.0096	0.001	0.001	0.000	0.000	0.000
		0.5	0.0037	0.000	0.000	0.000	0.000	0.000
	0.4	0.1	0.1656	0.009	0.006	0.003	0.001	0.000
		0.25	0.0880	0.002	0.001	0.000	0.000	0.000
		0.5	0.0420	0.002	0.000	0.000	0.000	0.000
<b>Coverage Rate</b>								
0	0.1	0.1	0	-	-	-	-	-
		0.25	0	-	-	-	-	-
		0.5	0	-	-	-	-	-
	0.2	0.1	0.0255	0.982	0.901	0.913	0.922	0.933
		0.25	0.0096	0.991	0.979	0.939	0.941	0.945
		0.5	0.0037	1.000	0.996	0.949	0.940	0.944
	0.4	0.1	0.1656	0.845	0.878	0.921	0.932	0.944
		0.25	0.0880	0.898	0.911	0.926	0.939	0.946
		0.5	0.0420	0.930	0.932	0.928	0.924	0.948