

# Linear Model Simulations

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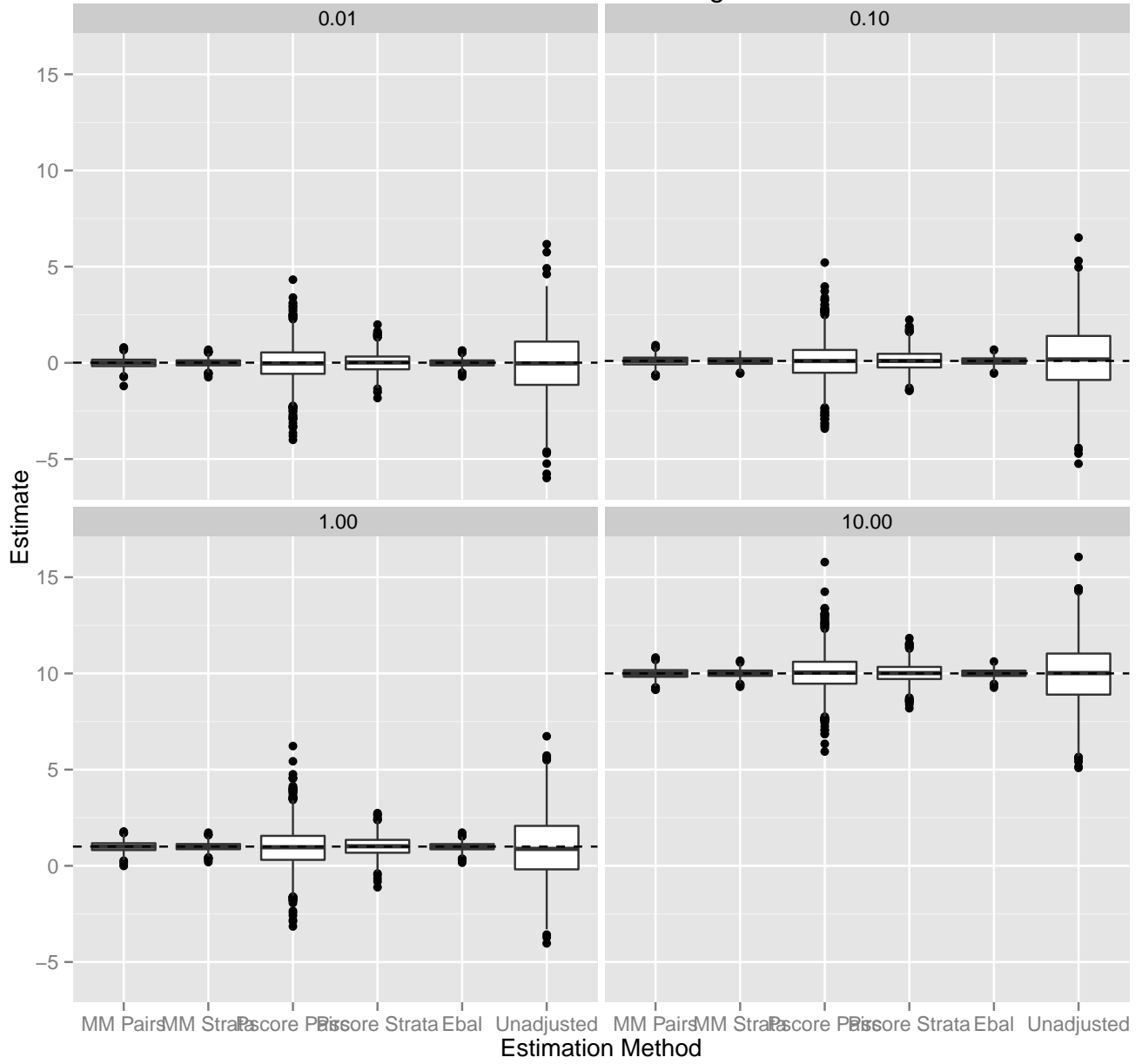
Set simulation parameters

```
set.seed(321)
gamma <- c(0.01, 0.1, 1, 10)
B <- 1000
N <- 100
```

## 1 Comparing Model-based Matching to Other Methods

### 1.1 Gaussian Errors in the Linear Model

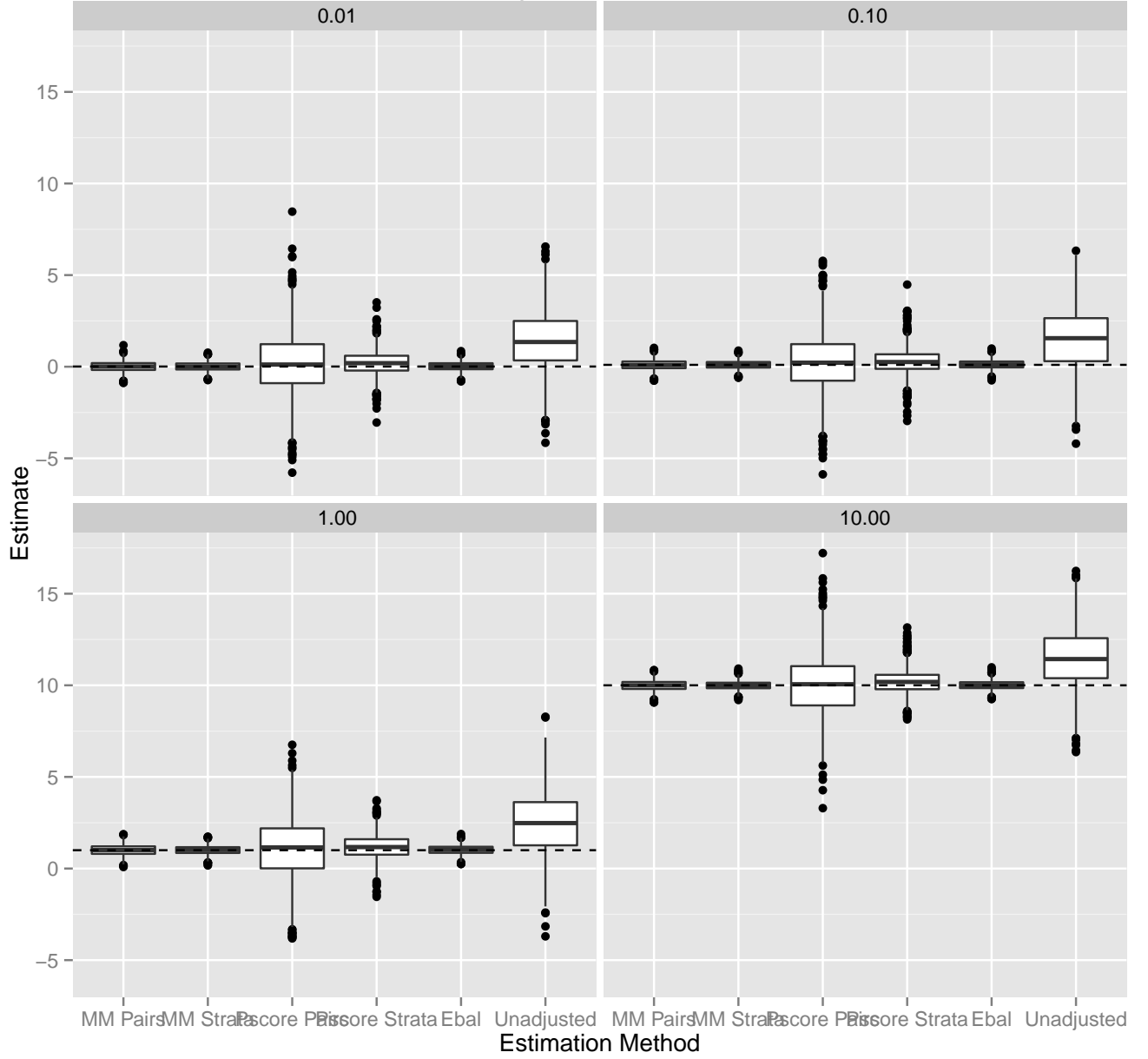
Estimates of Varying Levels of Constant Additive Treatment Effects  
Random Treatment Assignment



	0.01	0.1	1	10
MM Pairs	0.257	0.263	0.264	0.260
MM Strata	0.203	0.200	0.210	0.204
Pscore Pairs	1.030	1.033	1.139	1.043
Pscore Strata	0.520	0.548	0.519	0.512
Ebal	0.206	0.201	0.212	0.205
Unadjusted	1.683	1.705	1.646	1.579

Table 1: RMSE for various treatment effects; Random Treatment Assignment

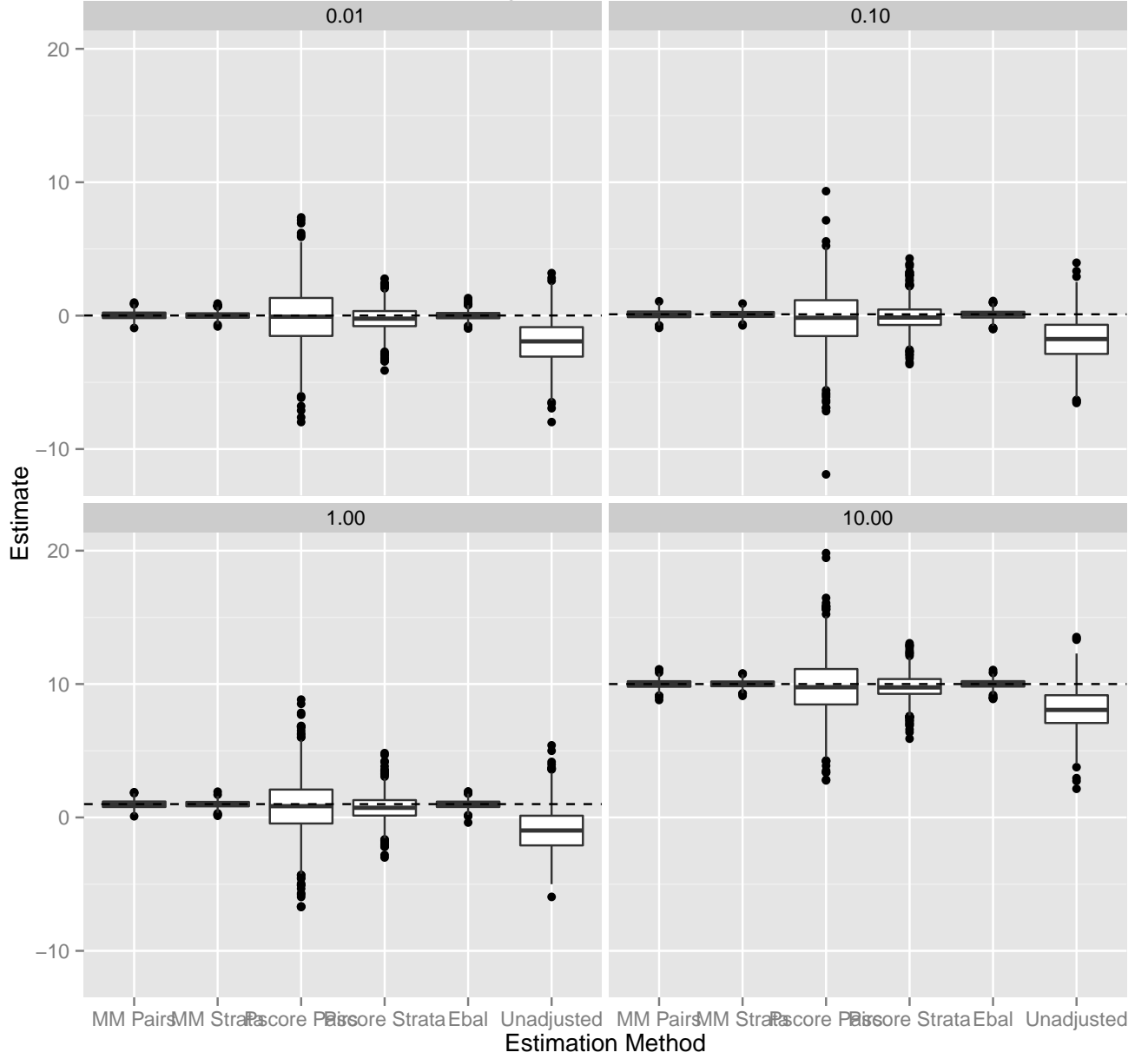
Estimates of Varying Levels of Constant Additive Treatment Effects  
Treatment Assignment with  $\text{Cov}(T, X_1) = 0.5$



	0.01	0.1	1	10
MM Pairs	0.287	0.291	0.296	0.296
MM Strata	0.239	0.234	0.234	0.237
Pscore Pairs	1.736	1.661	1.686	1.701
Pscore Strata	0.705	0.735	0.683	0.689
Ebal	0.250	0.243	0.251	0.248
Unadjusted	2.132	2.220	2.238	2.229

Table 2: RMSE for various treatment effects; Treatment Assignment with  $\text{cov}(T, X_1) = 0.5$

Estimates of Varying Levels of Constant Additive Treatment Effects  
Treatment Assignment with  $\text{Cov}(T, X_1) = -0.75$

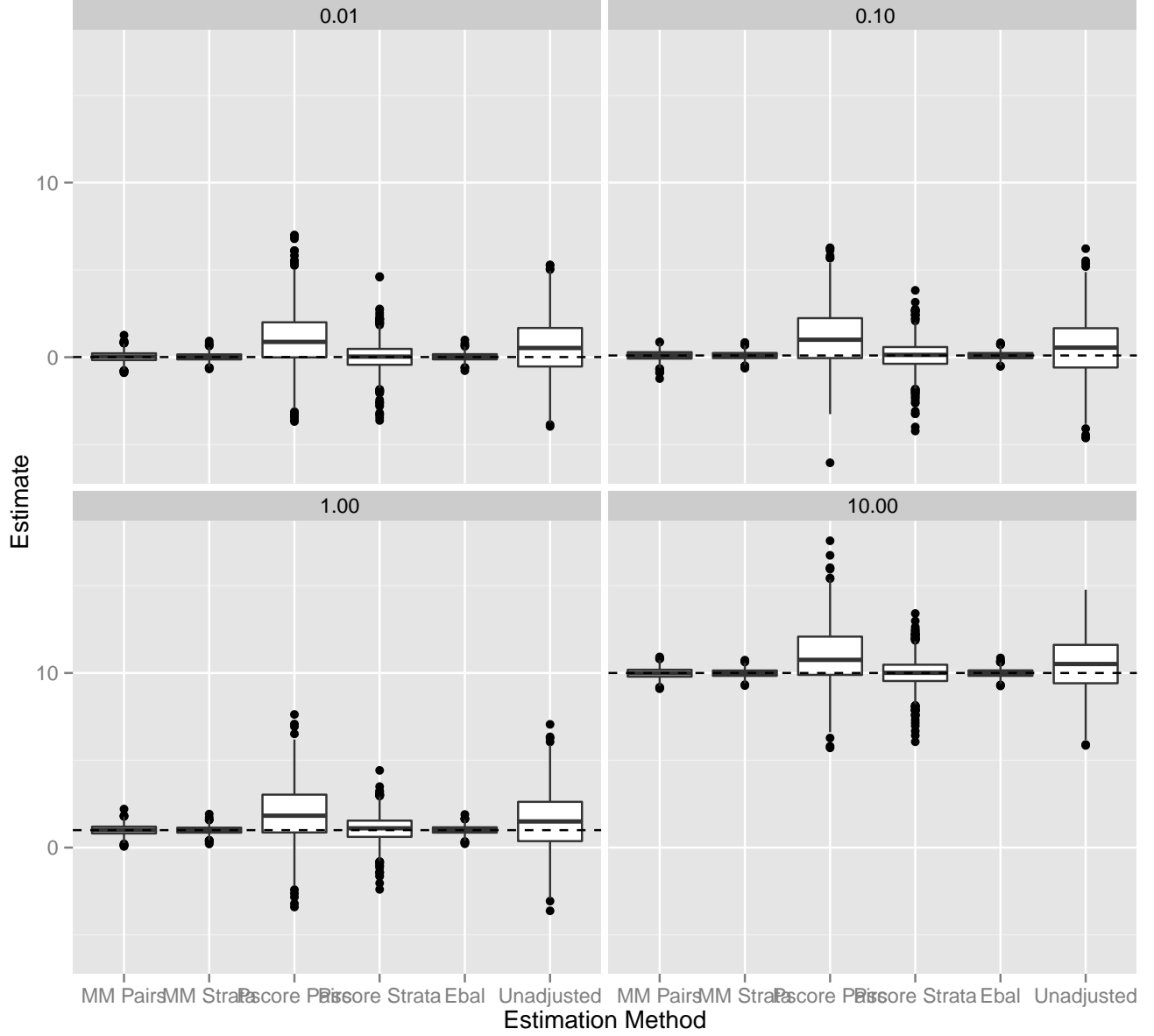


	0.01	0.1	1	10
MM Pairs	0.302	0.313	0.292	0.304
MM Strata	0.256	0.266	0.245	0.262
Pscore Pairs	2.143	2.160	2.134	2.164
Pscore Strata	0.945	1.057	0.991	0.967
Ebal	0.310	0.319	0.300	0.308
Unadjusted	2.555	2.476	2.564	2.489

Table 3: RMSE for various treatment effects; Treatment Assignment with  $\text{cov}(T, X_1) = -0.75$

## 1.2 Misspecified Propensity Score Estimates

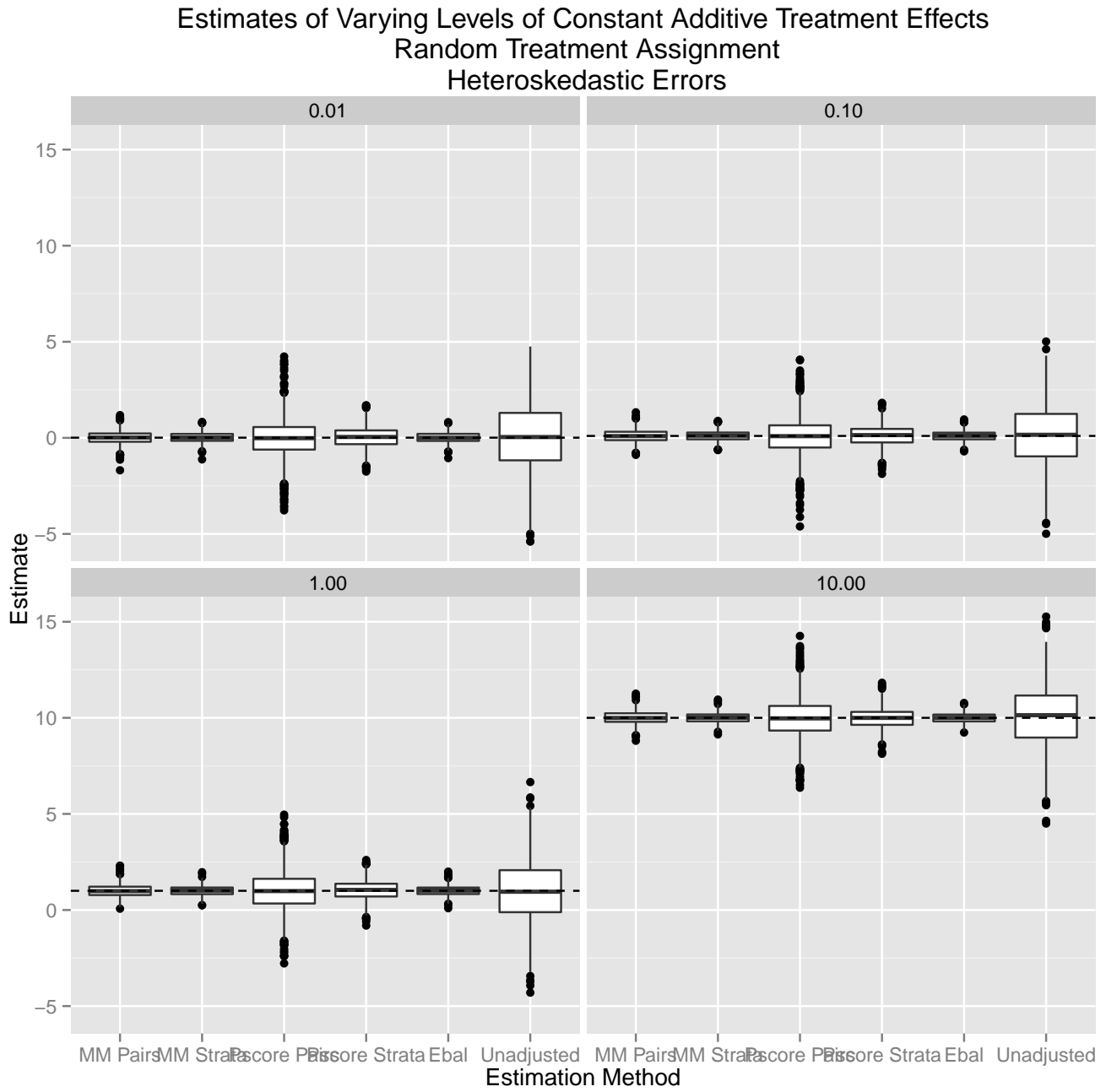
Estimates of Varying Levels of Constant Additive Treatment Effects  
Treatment Assignment with  $\text{Cov}(T, X_1) = 0.5$   
Misspecified Propensity Score Model



	0.01	0.1	1	10
MM Pairs	0.293	0.288	0.292	0.288
MM Strata	0.222	0.219	0.220	0.221
Pscore Pairs	1.892	1.953	1.887	1.918
Pscore Strata	0.850	0.839	0.780	0.829
Ebal	0.221	0.217	0.222	0.223
Unadjusted	1.766	1.694	1.769	1.725

Table 4: RMSE for various treatment effects; Treatment Assignment with  $\text{cov}(T, X_1) = 0.5$ ; Misspecified Propensity Score Model

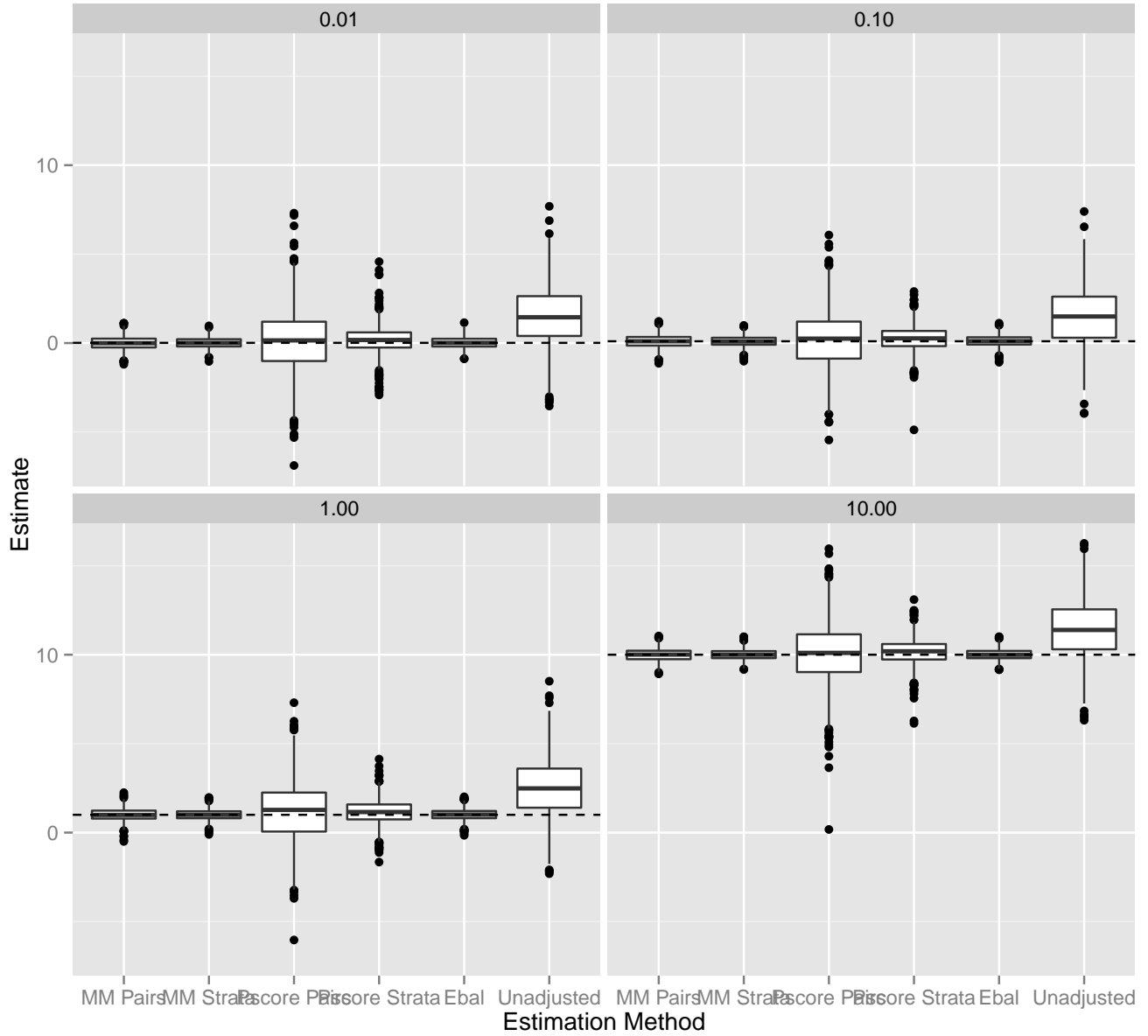
### 1.3 Heteroskedastic Linear Model Errors



	0.01	0.1	1	10
MM Pairs	0.335	0.330	0.322	0.339
MM Strata	0.267	0.262	0.251	0.256
Pscore Pairs	1.077	1.088	1.146	1.091
Pscore Strata	0.548	0.548	0.521	0.538
Ebal	0.268	0.263	0.259	0.256
Unadjusted	1.753	1.640	1.641	1.627

Table 5: RMSE for various treatment effects; Random Treatment Assignment; Heteroskedastic Errors

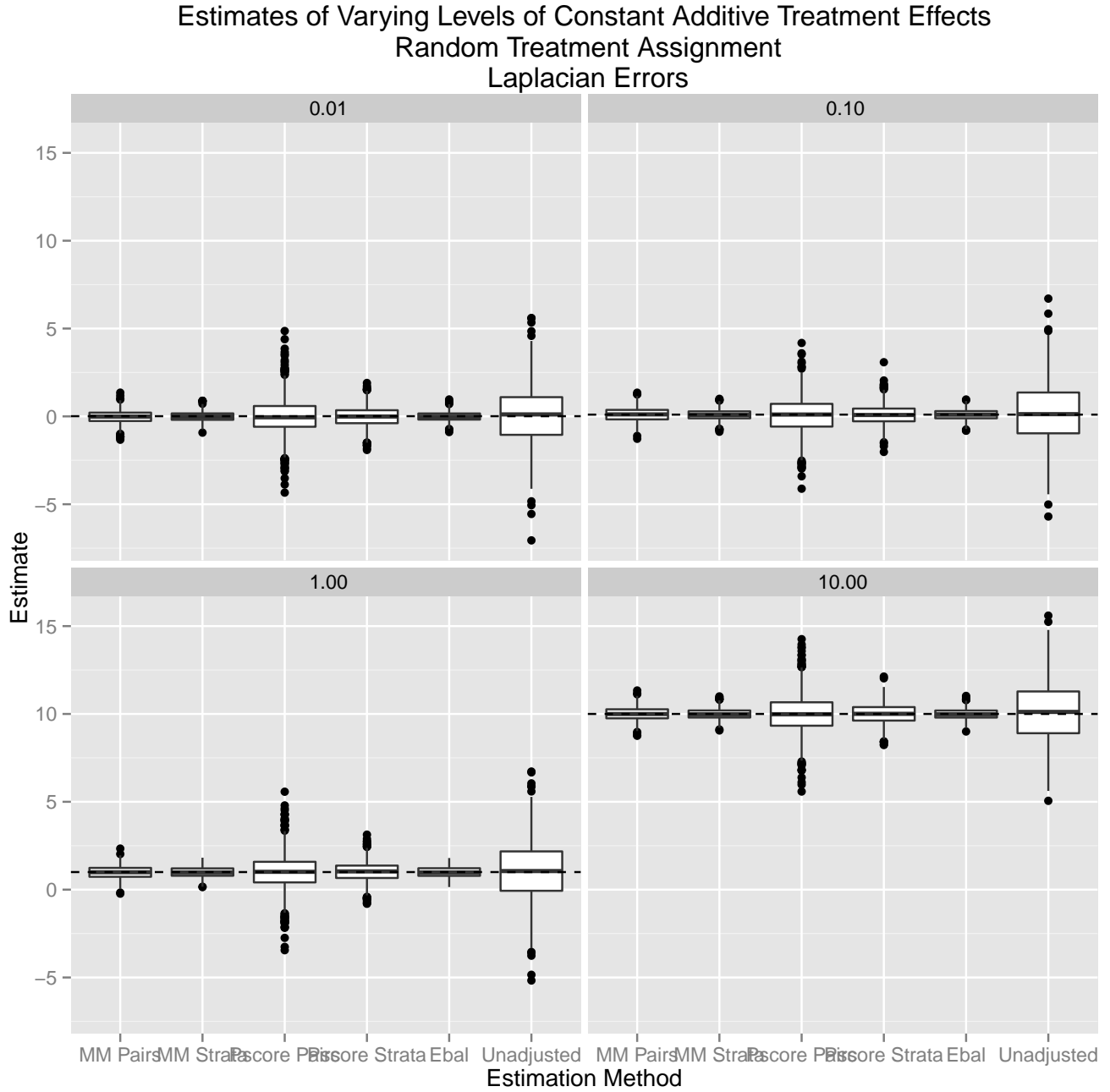
Estimates of Varying Levels of Constant Additive Treatment Effects  
Treatment Assignment with  $\text{Cov}(T, X_1) = 0.5$   
Heteroskedastic Errors



	0.01	0.1	1	10
MM Pairs	0.369	0.371	0.359	0.357
MM Strata	0.299	0.297	0.297	0.296
Pscore Pairs	1.789	1.679	1.692	1.735
Pscore Strata	0.782	0.706	0.692	0.735
Ebal	0.312	0.313	0.313	0.309
Unadjusted	2.246	2.099	2.257	2.205

Table 6: RMSE for various treatment effects; Treatment Assignment with  $\text{cov}(T, X_1) = 0.5$ ; Heteroskedastic Errors

## 1.4 Heavy-tailed Linear Model Errors

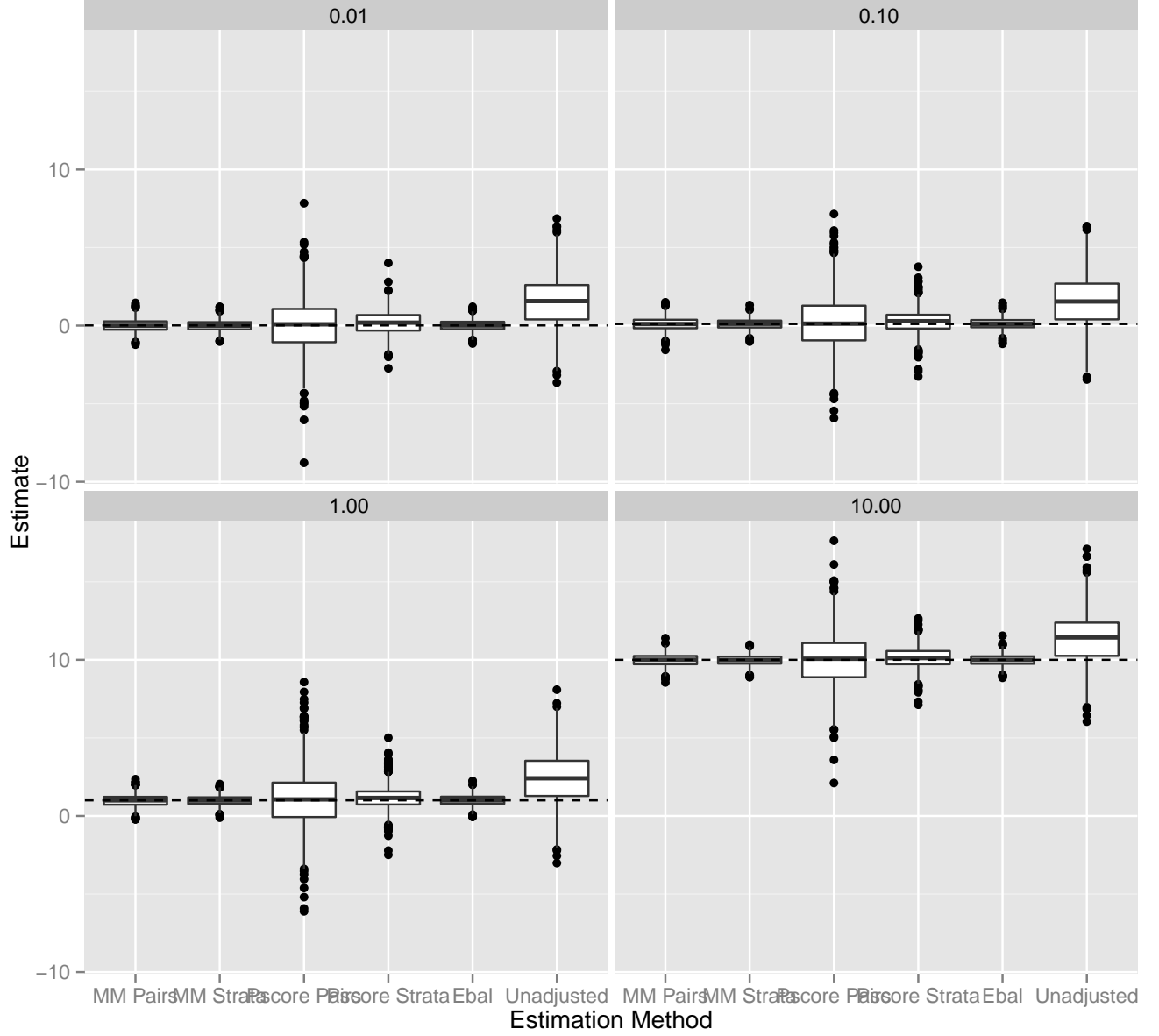


	0.01	0.1	1	10
MM Pairs	0.372	0.386	0.378	0.380
MM Strata	0.282	0.299	0.293	0.303
Pscore Pairs	1.076	1.043	1.063	1.134
Pscore Strata	0.569	0.572	0.566	0.573
Ebal	0.276	0.296	0.291	0.303
Unadjusted	1.670	1.700	1.694	1.722

Table 7: RMSE for various treatment effects; Random Treatment Assignment; Laplacian Errors



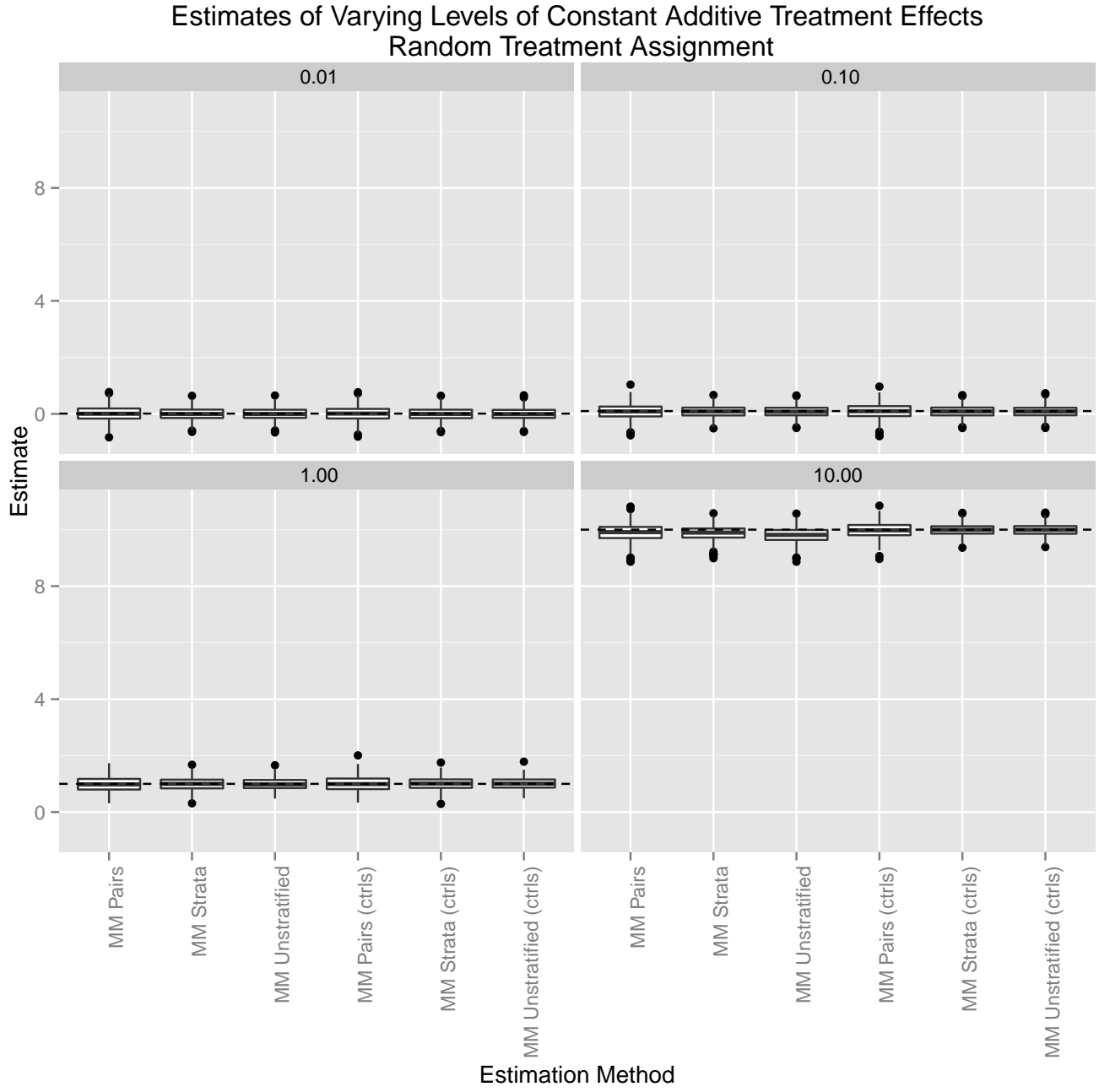
Estimates of Varying Levels of Constant Additive Treatment Effects  
Treatment Assignment with  $\text{Cov}(T, X_1) = 0.5$   
Laplacian Errors



	0.01	0.1	1	10
MM Pairs	0.402	0.411	0.397	0.398
MM Strata	0.337	0.333	0.330	0.332
Pscore Pairs	1.688	1.752	1.831	1.721
Pscore Strata	0.729	0.767	0.775	0.682
Ebal	0.362	0.355	0.353	0.351
Unadjusted	2.263	2.211	2.205	2.153

Table 8: RMSE for various treatment effects; Treatment Assignment with  $\text{cov}(T, X_1) = 0.5$ ; Laplacian Errors

## 2 Comparing Variants of Model-based Matching

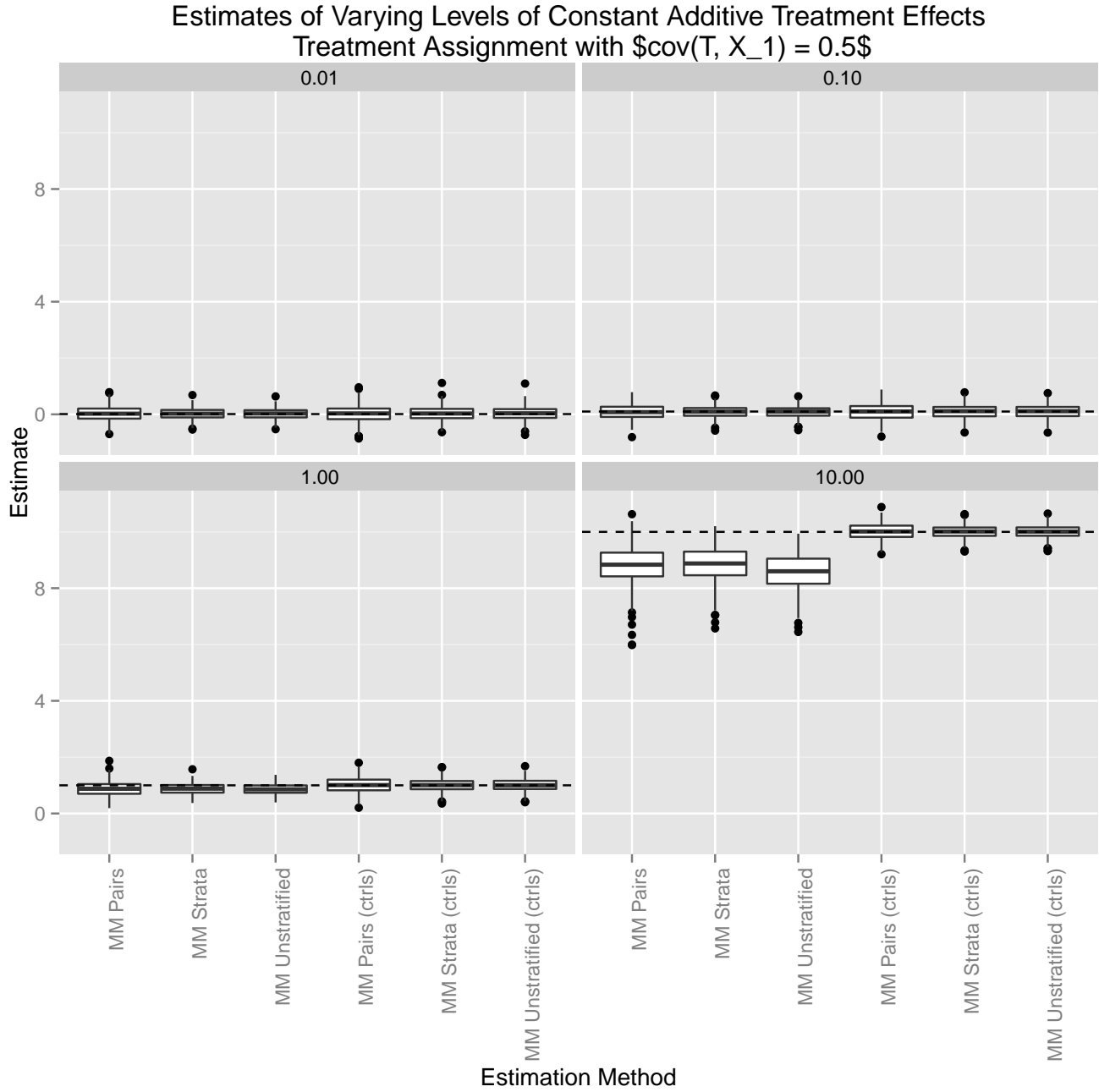


	0.01	0.1	1	10
MM Pairs	0.272	0.270	0.272	0.324
MM Strata	0.210	0.201	0.209	0.273
MM Unstratified	0.205	0.198	0.199	0.328
MM Pairs (ctrls)	0.268	0.270	0.267	0.268
MM Strata (ctrls)	0.214	0.205	0.210	0.204
MM Unstratified (ctrls)	0.211	0.204	0.204	0.203

Table 9: RMSE for various treatment effects; Random Treatment Assignment

	0.01	0.1	1	10
MM Pairs	-0.008	-0.026	-0.017	-0.109
MM Strata	-0.007	-0.018	0.001	-0.120
MM Unstratified	-0.006	-0.021	-0.008	-0.196
MM Pairs (ctrls)	-0.005	-0.016	-0.001	-0.021
MM Strata (ctrls)	-0.009	-0.016	0.011	-0.011
MM Unstratified (ctrls)	-0.007	-0.018	0.011	-0.010

Table 10: Bias for estimators; Random Treatment Assignment

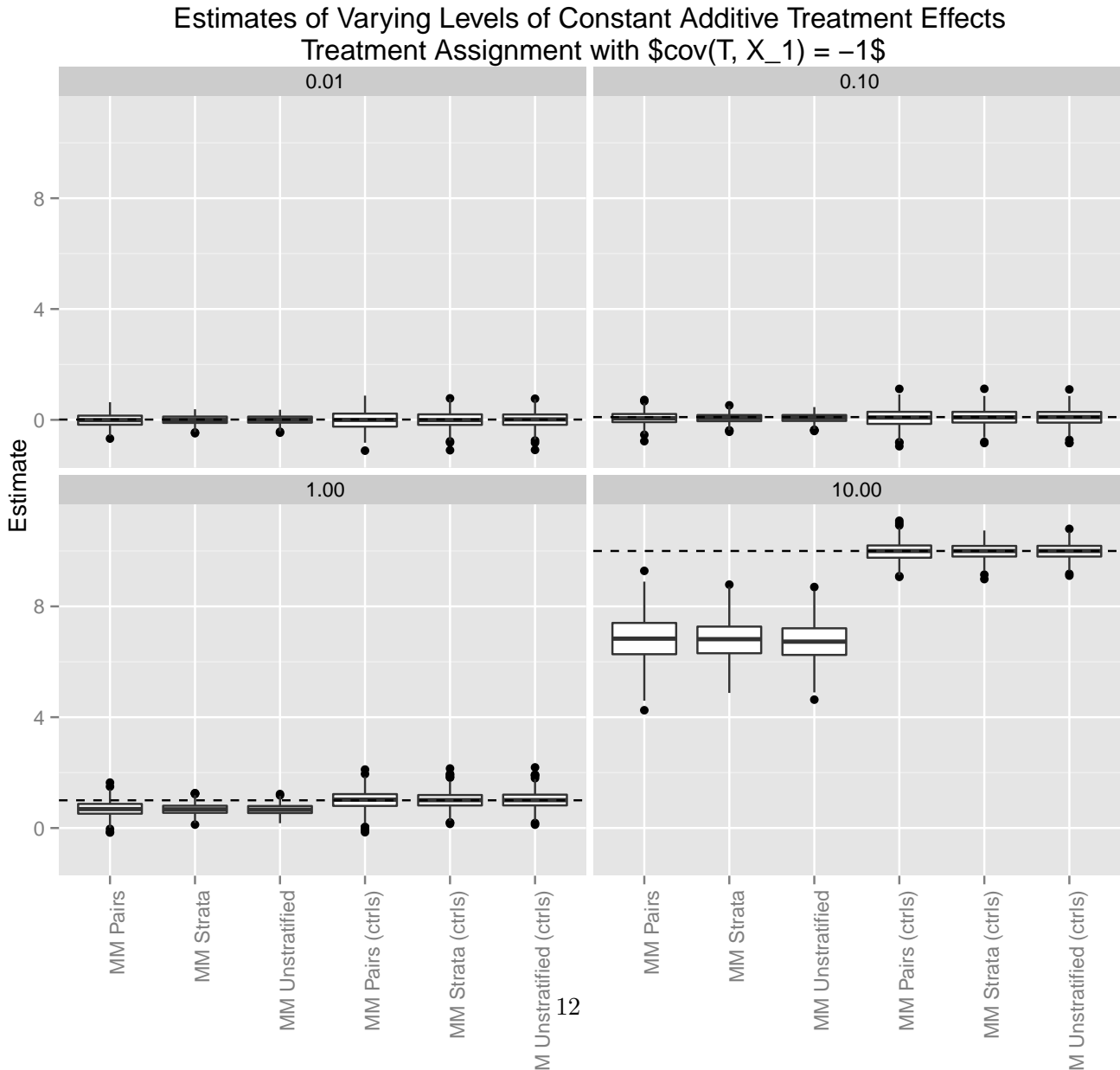


	0.01	0.1	1	10
MM Pairs	0.264	0.259	0.291	1.358
MM Strata	0.198	0.196	0.227	1.307
MM Unstratified	0.189	0.187	0.228	1.557
MM Pairs (ctrls)	0.299	0.283	0.267	0.278
MM Strata (ctrls)	0.245	0.234	0.218	0.220
MM Unstratified (ctrls)	0.241	0.231	0.216	0.218

Table 11: RMSE for various treatment effects; Treatment Assignment with  $cov(T, X_1) = 0.5$

	0.01	0.1	1	10
MM Pairs	0.016	-0.015	-0.119	-1.185
MM Strata	0.011	-0.010	-0.123	-1.167
MM Unstratified	0.013	-0.010	-0.138	-1.424
MM Pairs (ctrls)	0.020	-0.005	0.012	0.012
MM Strata (ctrls)	0.013	0.000	0.010	0.000
MM Unstratified (ctrls)	0.017	0.002	0.011	0.001

Table 12: Bias for estimators; Treatment Assignment with  $cov(T, X_1) = 0.5$



	0.01	0.1	1	10
MM Pairs	0.264	0.259	0.291	1.358
MM Strata	0.198	0.196	0.227	1.307
MM Unstratified	0.189	0.187	0.228	1.557
MM Pairs (ctrls)	0.299	0.283	0.267	0.278
MM Strata (ctrls)	0.245	0.234	0.218	0.220
MM Unstratified (ctrls)	0.241	0.231	0.216	0.218

Table 13: RMSE for various treatment effects; Treatment Assignment with  $cov(T, X_1) = -1$

	0.01	0.1	1	10
MM Pairs	-0.014	-0.042	-0.304	-3.186
MM Strata	-0.009	-0.036	-0.315	-3.201
MM Unstratified	-0.008	-0.035	-0.325	-3.284
MM Pairs (ctrls)	-0.009	-0.014	0.016	-0.012
MM Strata (ctrls)	-0.009	-0.009	0.012	-0.009
MM Unstratified (ctrls)	-0.008	-0.008	0.016	-0.011

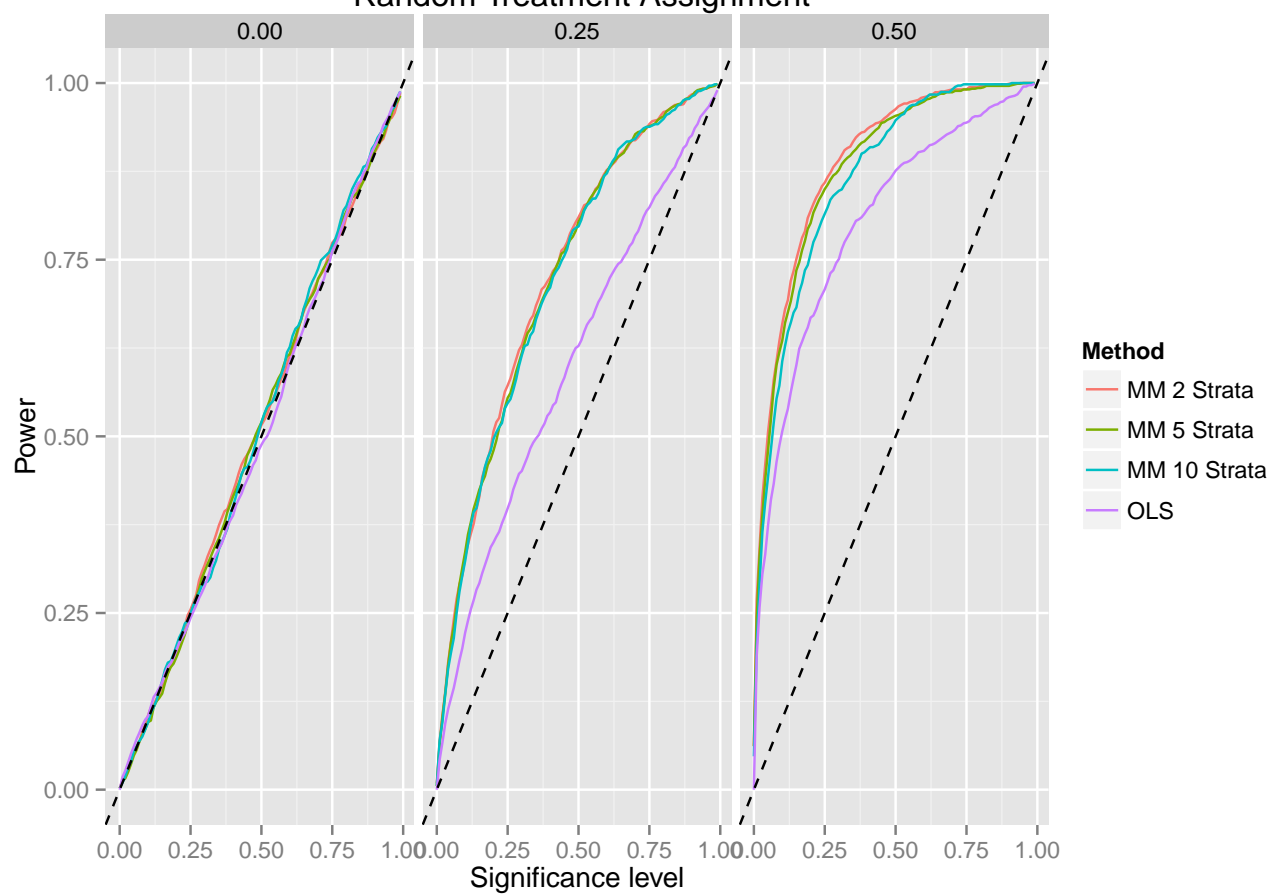
Table 14: Bias for estimators; Treatment Assignment with  $cov(T, X_1) = -1$

### 3 Hypothesis Testing

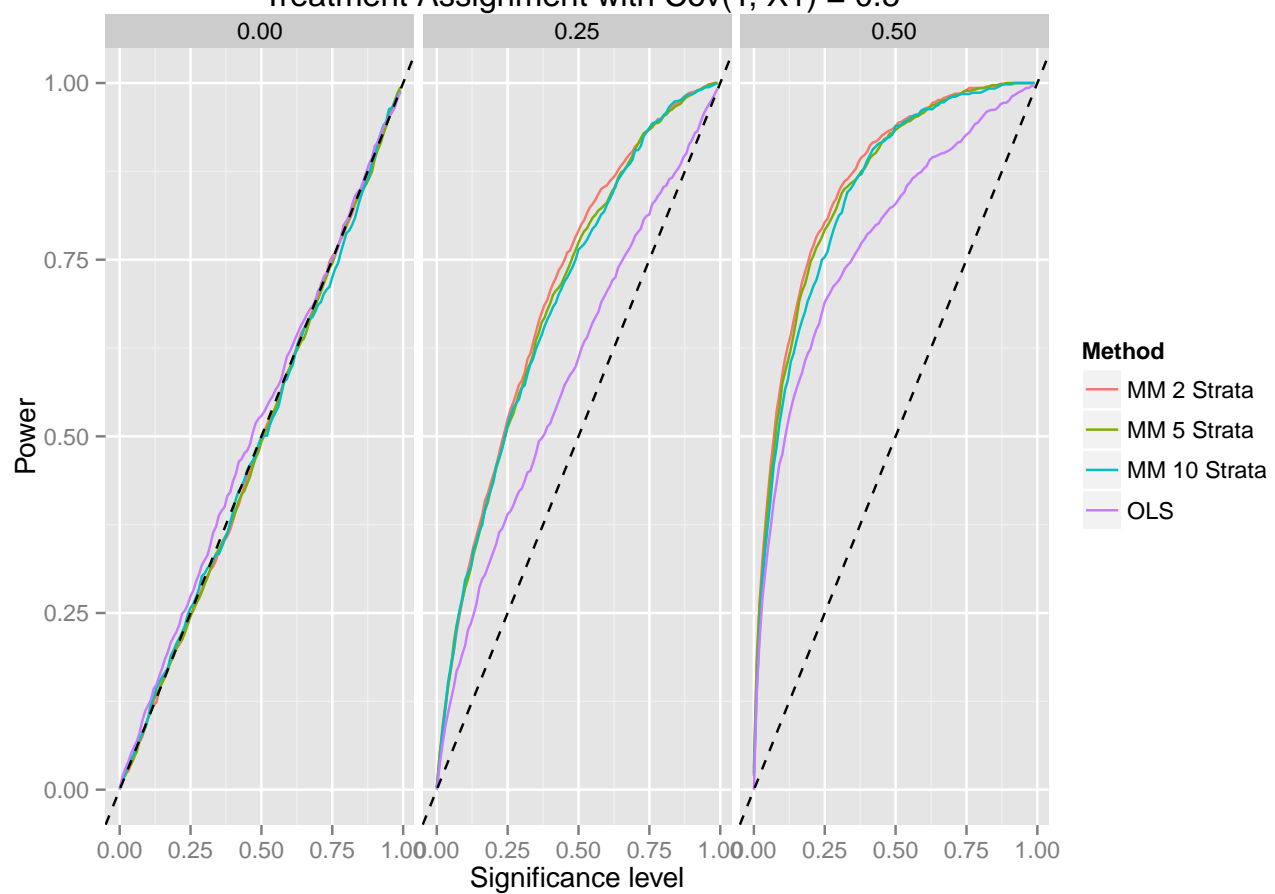
We compare the power of stratified permutation tests using model-based matching with different numbers of strata to the t-test from OLS.

We’ve uncovered an interesting problem: if we use estimates  $\hat{Y}$  based on the controls only, we get anti-conservative tests. The actual level of our permutation tests is much higher than the nominal level.

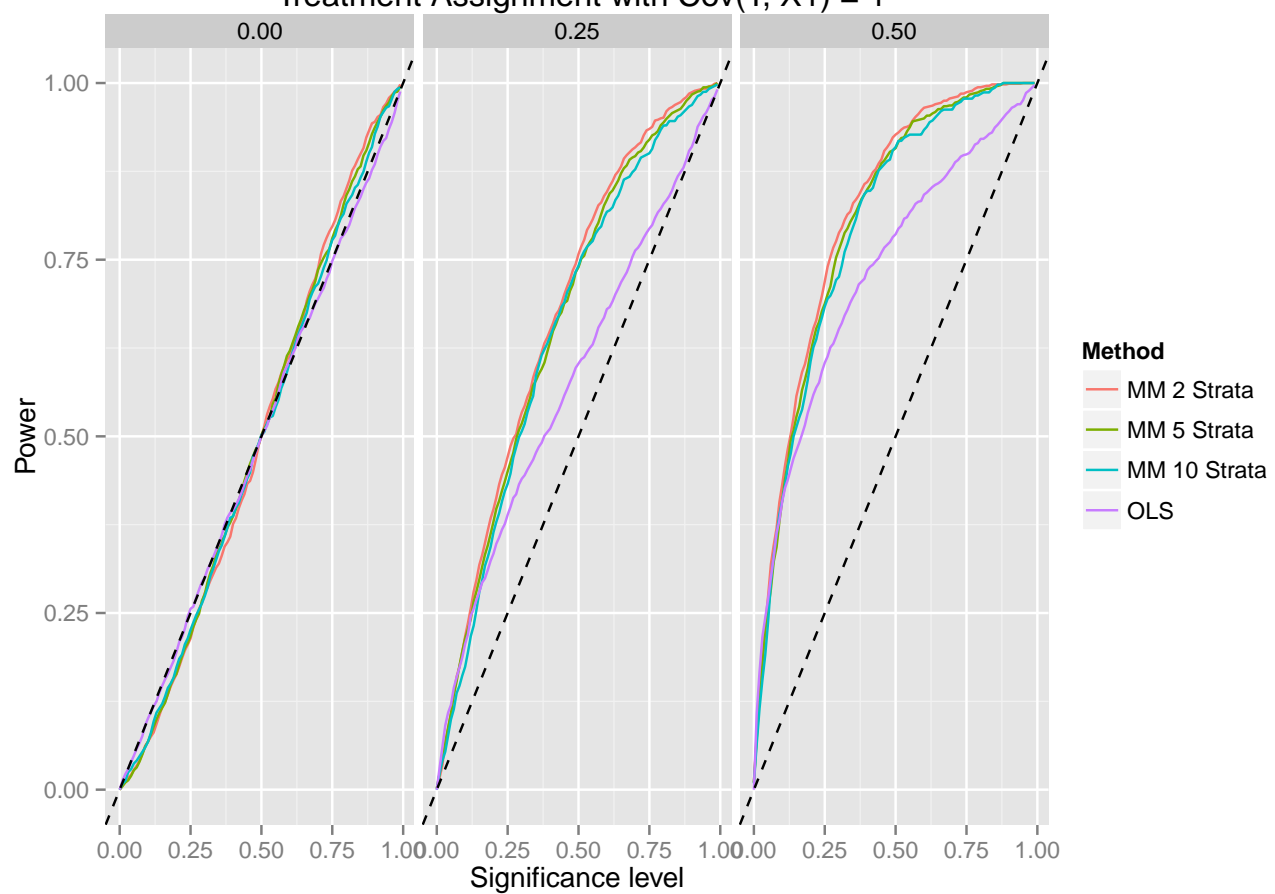
Power Curves for Varying Magnitude of Treatment Effects  
Random Treatment Assignment



Power Curves for Varying Magnitude of Treatment Effects  
Treatment Assignment with  $\text{Cov}(T, X_1) = 0.5$

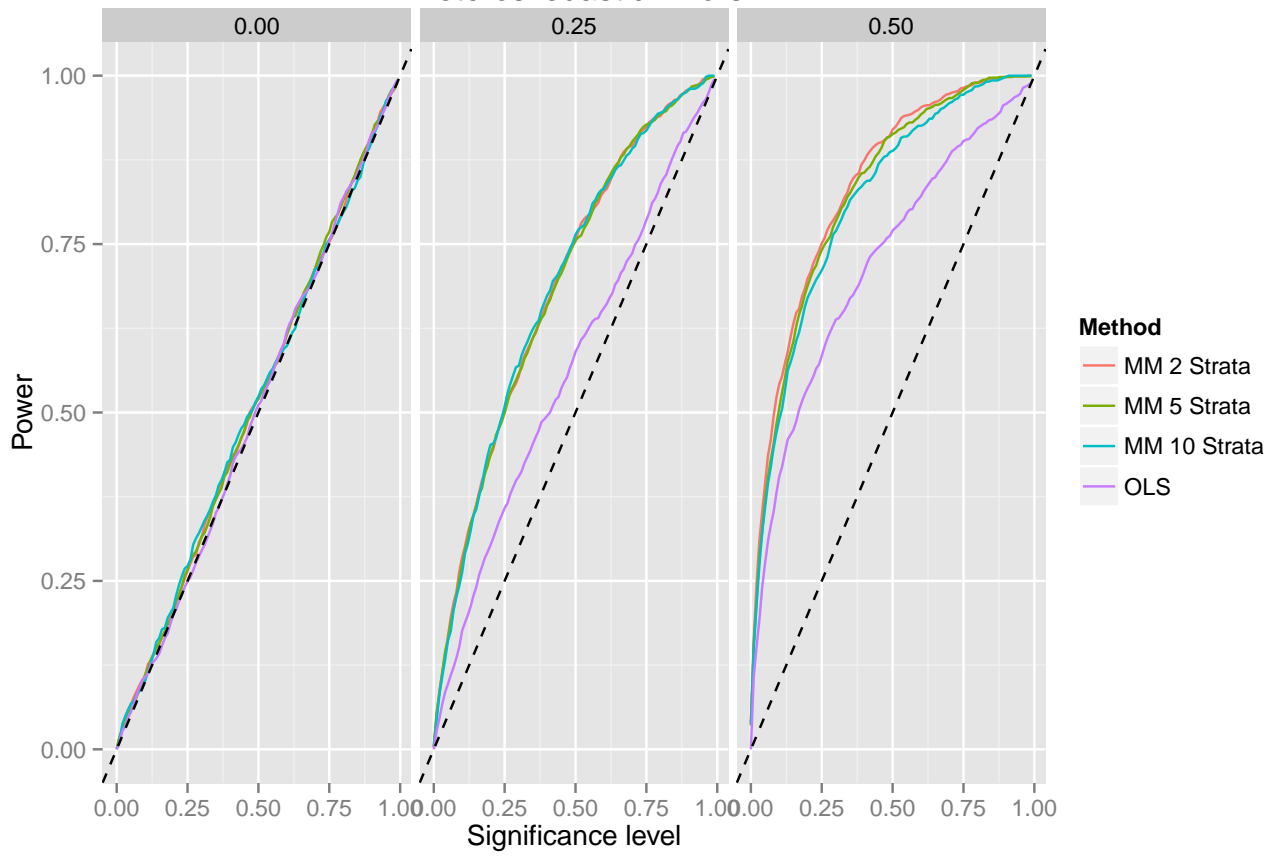


Power Curves for Varying Magnitude of Treatment Effects  
Treatment Assignment with  $\text{Cov}(T, X_1) = 1$





Power Curves for Varying Magnitude of Treatment Effects  
 Random Treatment Assignment  
 Heteroskedastic Errors



Power Curves for Varying Magnitude of Treatment Effects  
 Random Treatment Assignment  
 Laplacian Errors

