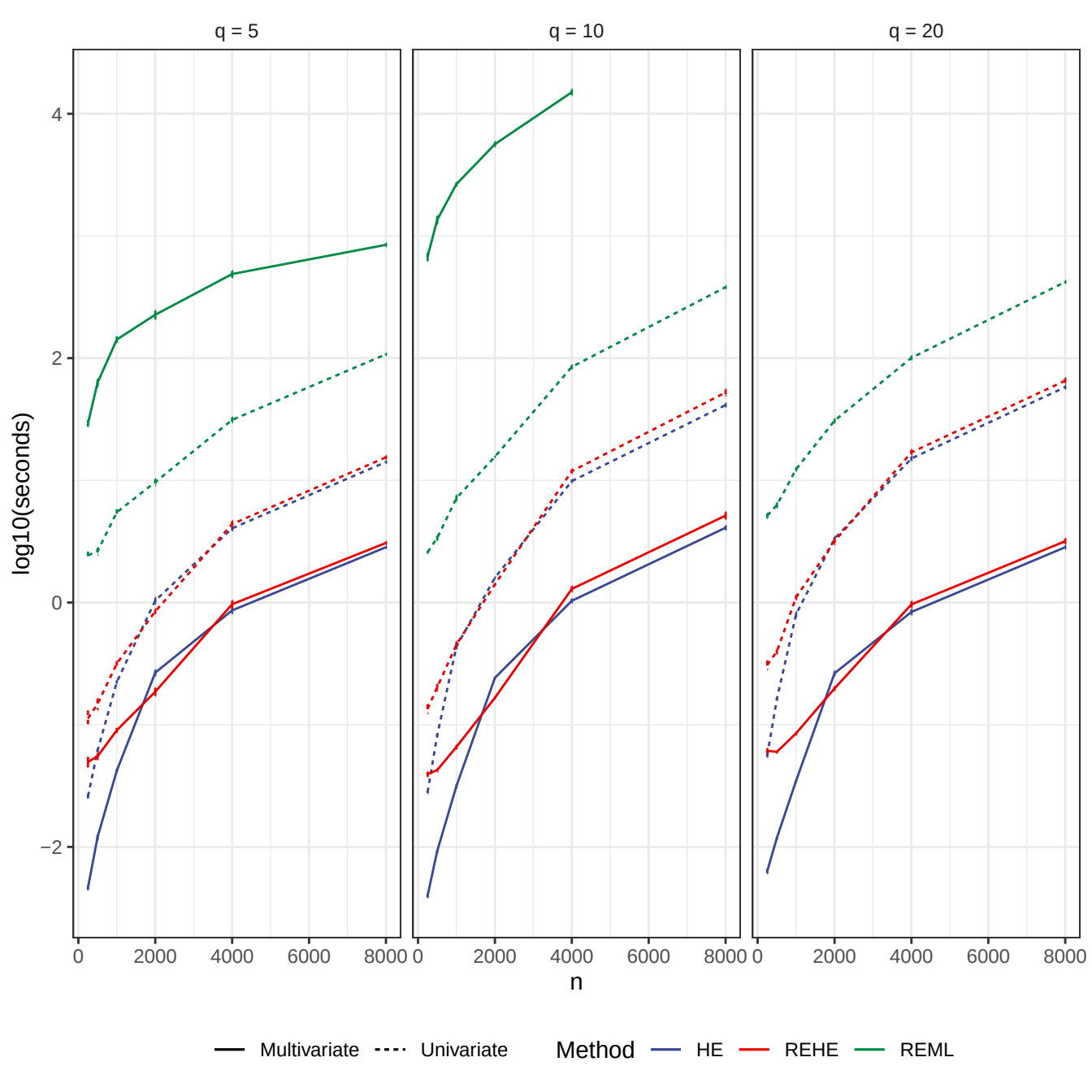
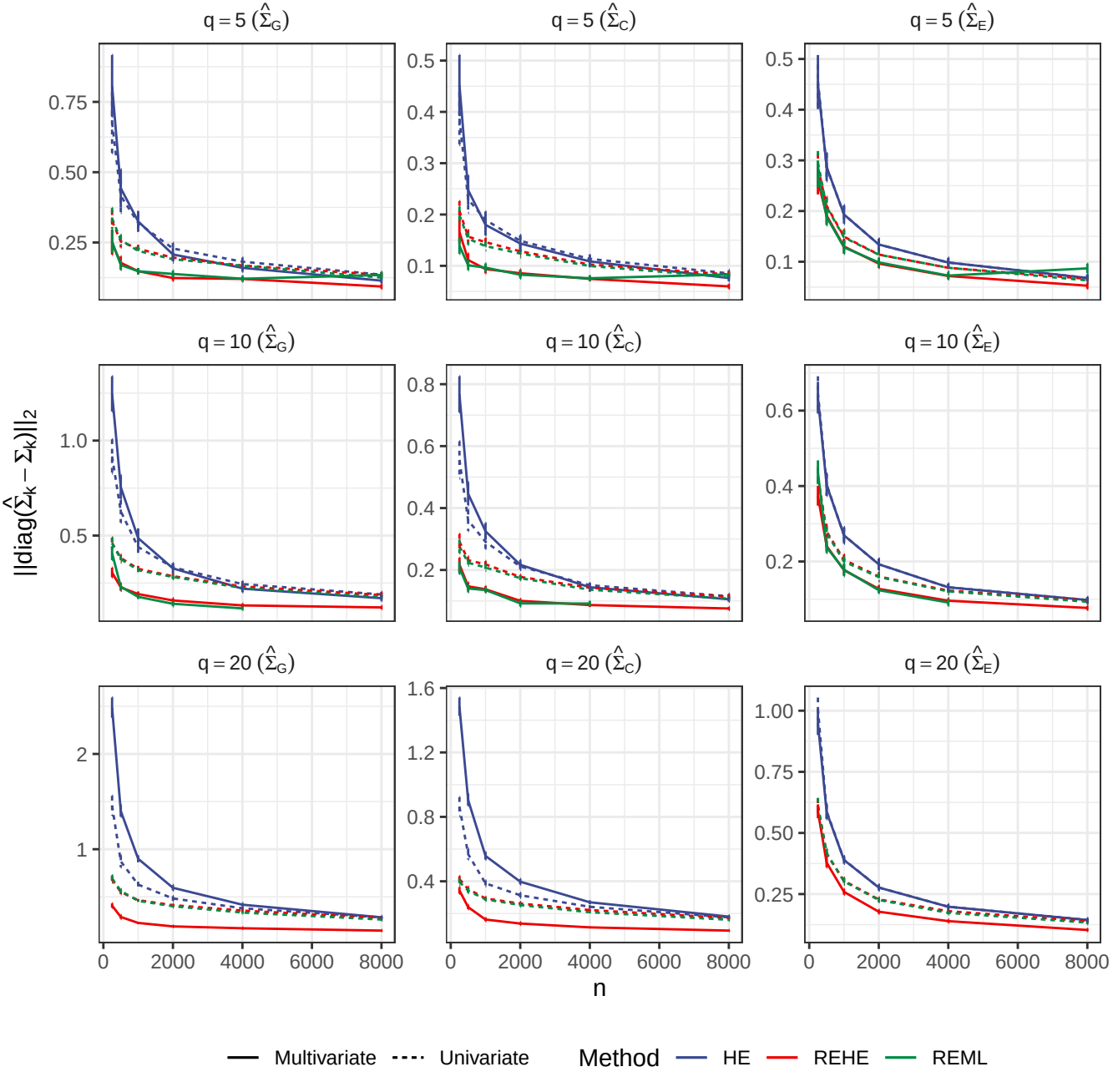
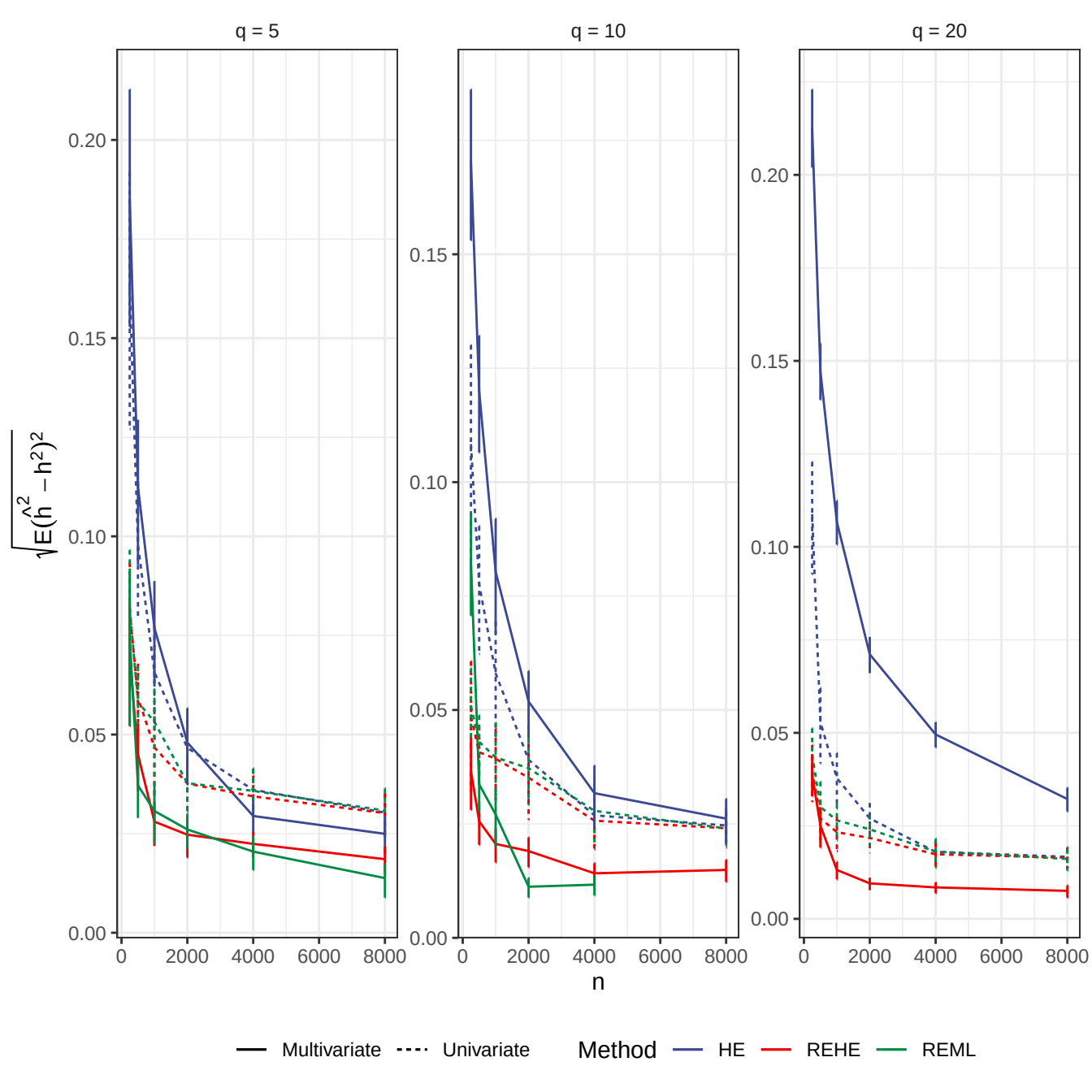
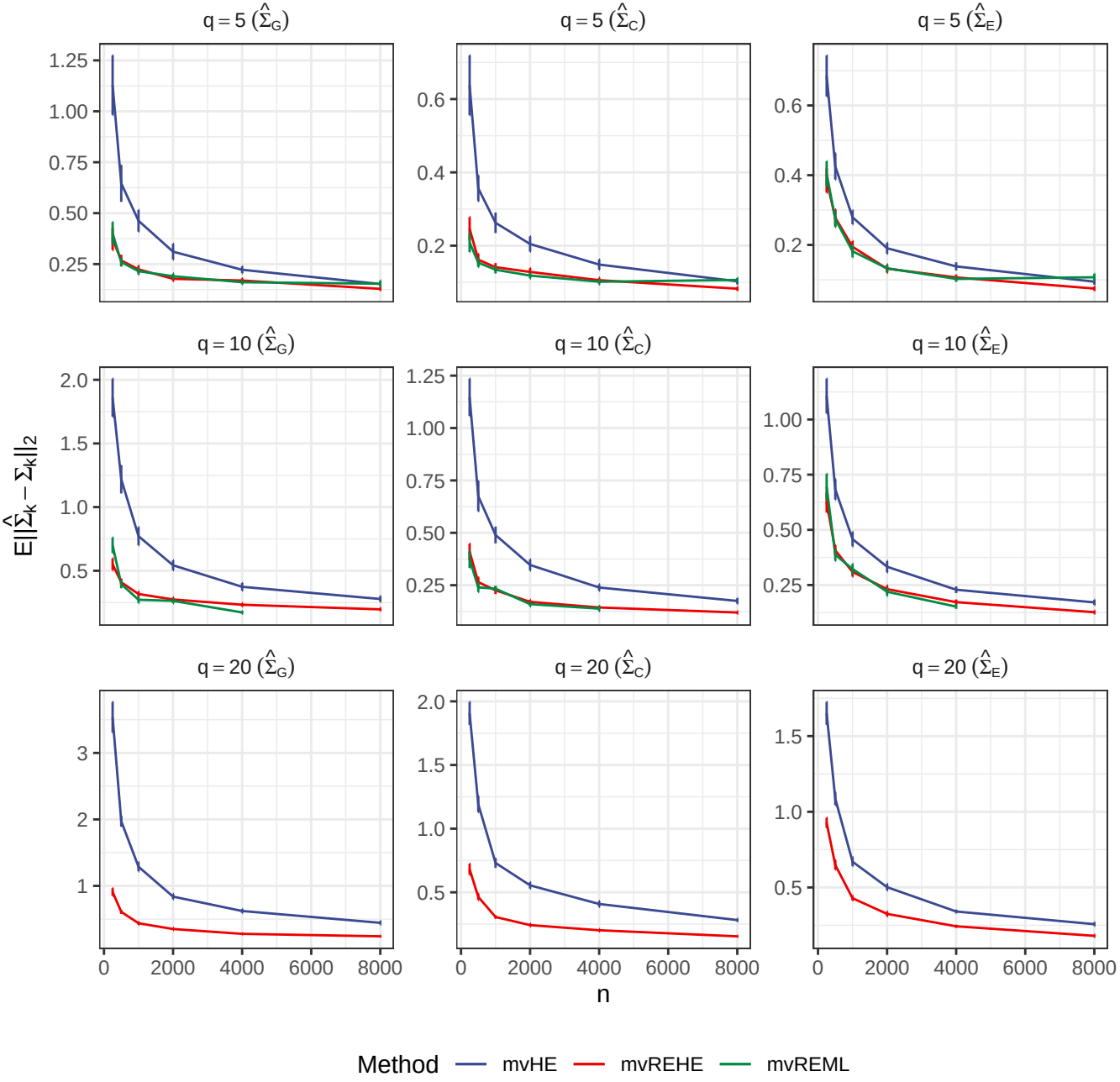
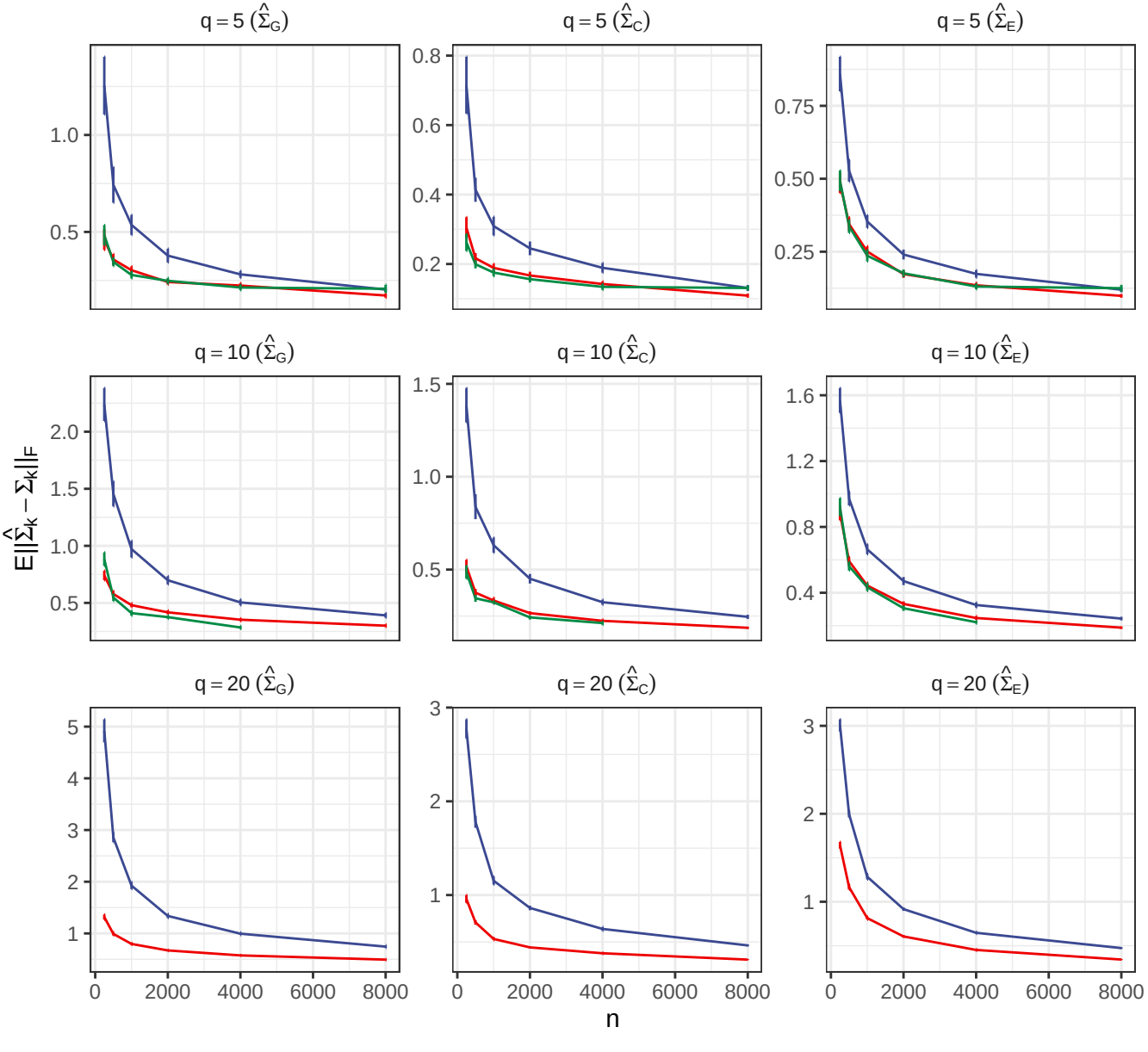
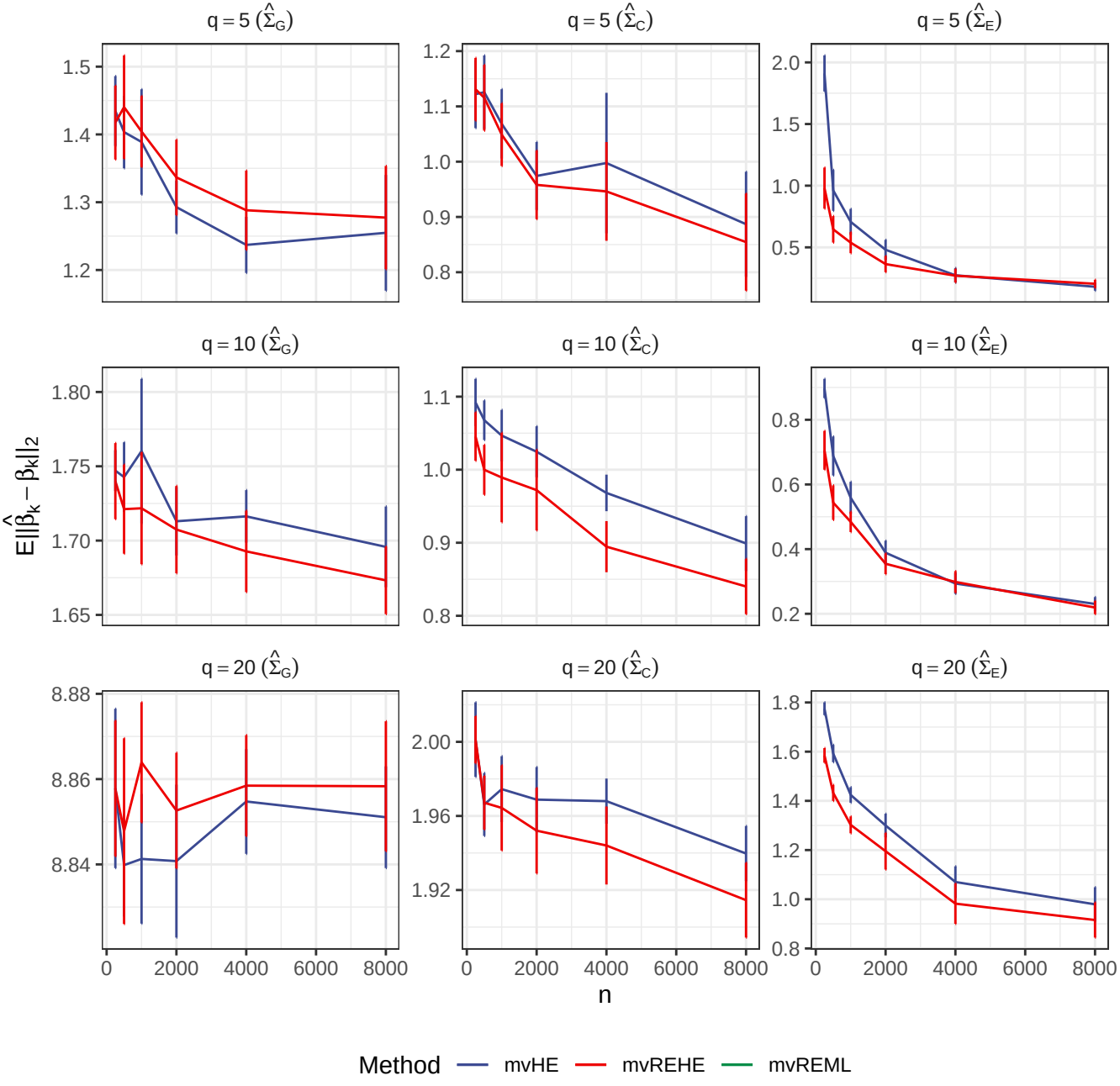

q = 5
q = 10
q = 20
log10(seconds)
4
2
0
−2
0
2000
4000
6000
8000
n
Multivariate
Univariate
Method
HE
REHE
REML

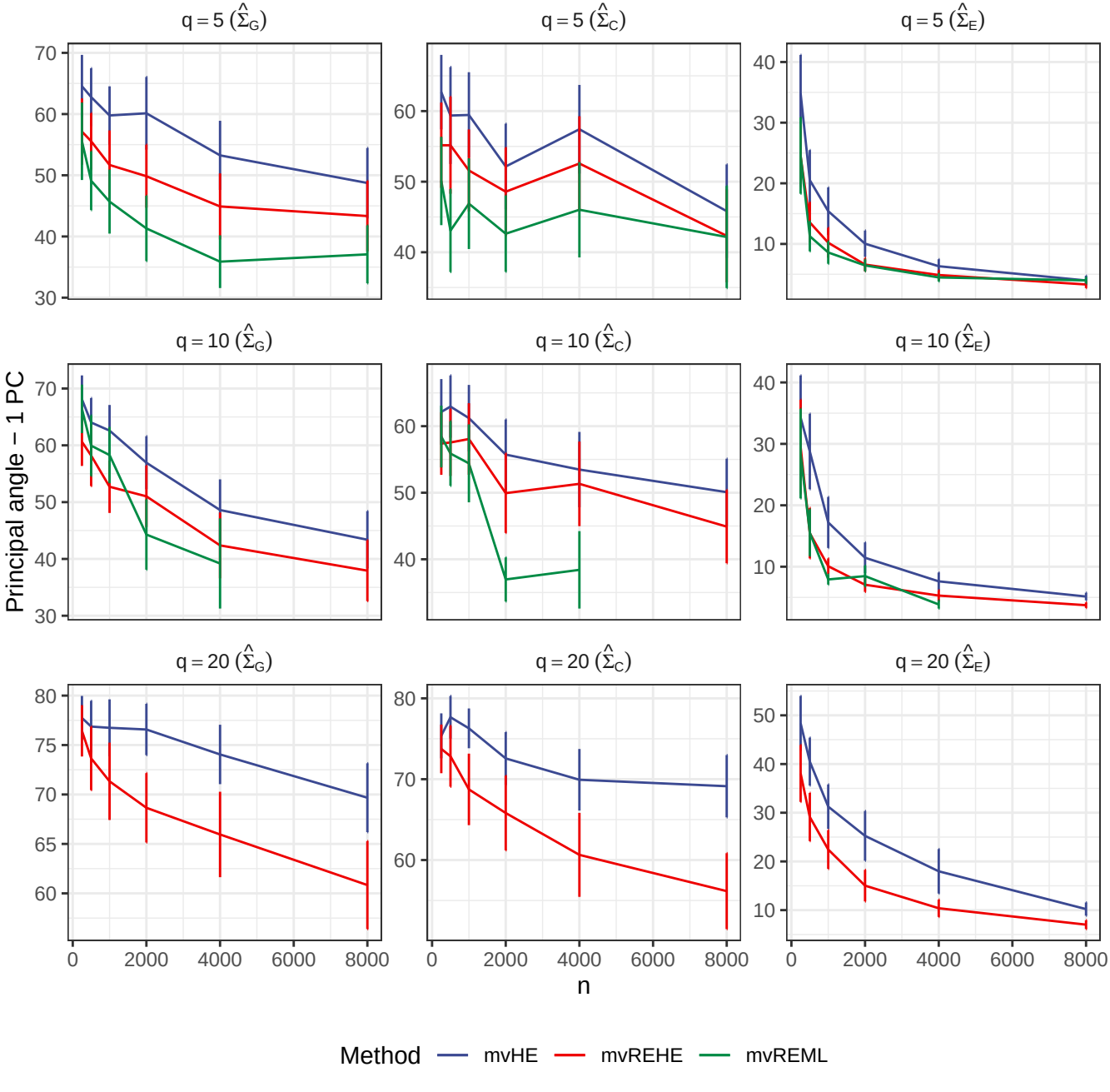

q = 5 ($\hat{\Sigma}_G$)
q = 5 ($\hat{\Sigma}_C$)
q = 5 ($\hat{\Sigma}_E$)
q = 10 ($\hat{\Sigma}_G$)
q = 10 ($\hat{\Sigma}_C$)
q = 10 ($\hat{\Sigma}_E$)
q = 20 ($\hat{\Sigma}_G$)
q = 20 ($\hat{\Sigma}_C$)
q = 20 ($\hat{\Sigma}_E$)
$||\text{diag}(\hat{\Sigma}_k - \Sigma_k)||_2$
n
Multivariate
Univariate
Method
HE
REHE
REML

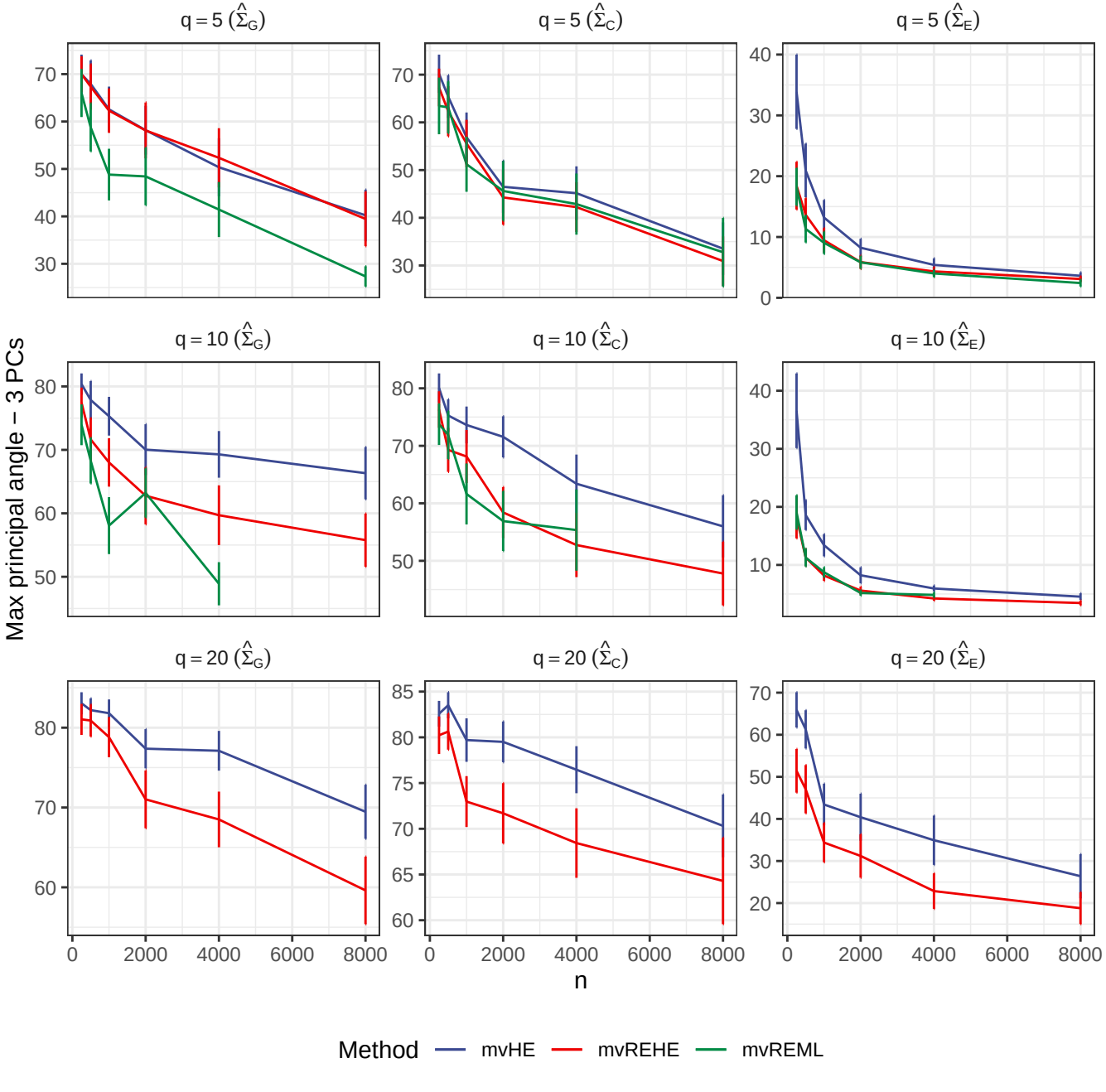

q = 5
q = 10
q = 20
$\sqrt{E(\hat{h}^2 - h^2)^2}$
0.20
0.15
0.10
0.05
0.00
0
2000
4000
6000
8000
n
Multivariate
Univariate
Method
HE
REHE
REML


q = 5 ($\hat{\Sigma}_G$)
q = 5 ($\hat{\Sigma}_C$)
q = 5 ($\hat{\Sigma}_E$)
q = 10 ($\hat{\Sigma}_G$)
q = 10 ($\hat{\Sigma}_C$)
q = 10 ($\hat{\Sigma}_E$)
q = 20 ($\hat{\Sigma}_G$)
q = 20 ($\hat{\Sigma}_C$)
q = 20 ($\hat{\Sigma}_E$)
$E\|\hat{\Sigma}_k - \Sigma_k\|_2$
n
Method
mvHE
mvREHE
mvREML


q = 5 ($\hat{\Sigma}_G$)
q = 5 ($\hat{\Sigma}_C$)
q = 5 ($\hat{\Sigma}_E$)
q = 10 ($\hat{\Sigma}_G$)
q = 10 ($\hat{\Sigma}_C$)
q = 10 ($\hat{\Sigma}_E$)
q = 20 ($\hat{\Sigma}_G$)
q = 20 ($\hat{\Sigma}_C$)
q = 20 ($\hat{\Sigma}_E$)
$E\|\hat{\Sigma}_k - \Sigma_k\|_F$
n
Method
mvHE
mvREHE
mvREML


q = 5 ($\hat{\Sigma}_G$)
q = 5 ($\hat{\Sigma}_C$)
q = 5 ($\hat{\Sigma}_E$)
q = 10 ($\hat{\Sigma}_G$)
q = 10 ($\hat{\Sigma}_C$)
q = 10 ($\hat{\Sigma}_E$)
q = 20 ($\hat{\Sigma}_G$)
q = 20 ($\hat{\Sigma}_C$)
q = 20 ($\hat{\Sigma}_E$)
$E\|\hat{\beta}_k - \beta_k\|_2$
n
Method
mvHE
mvREHE
mvREML


q = 5 ($\hat{\Sigma}_G$)
q = 5 ($\hat{\Sigma}_C$)
q = 5 ($\hat{\Sigma}_E$)
q = 10 ($\hat{\Sigma}_G$)
q = 10 ($\hat{\Sigma}_C$)
q = 10 ($\hat{\Sigma}_E$)
q = 20 ($\hat{\Sigma}_G$)
q = 20 ($\hat{\Sigma}_C$)
q = 20 ($\hat{\Sigma}_E$)
Principal angle – 1 PC
n
Method
mvHE
mvREHE
mvREML


q = 5 ($\hat{\Sigma}_G$)
q = 5 ($\hat{\Sigma}_C$)
q = 5 ($\hat{\Sigma}_E$)
q = 10 ($\hat{\Sigma}_G$)
q = 10 ($\hat{\Sigma}_C$)
q = 10 ($\hat{\Sigma}_E$)
q = 20 ($\hat{\Sigma}_G$)
q = 20 ($\hat{\Sigma}_C$)
q = 20 ($\hat{\Sigma}_E$)
Max principal angle – 3 PCs
n
Method
mvHE
mvREHE
mvREML