



**Figure S9** Comparisons of  $\rho_{FastEPRR}$  with and without  $\xi_1'$ .  $\hat{\rho}$  was estimated without  $\xi_1'$  (A-C)

and with  $\xi_1'$  (D-F) for the sample sizes  $n = 50$  (A, D),  $n = 100$  (B, E) and  $n = 200$  (C, F).

The number of segregating site  $S = 45$  ( $n = 50$ ),  $52$  ( $n = 100$ ) and  $59$  ( $n = 200$ ).