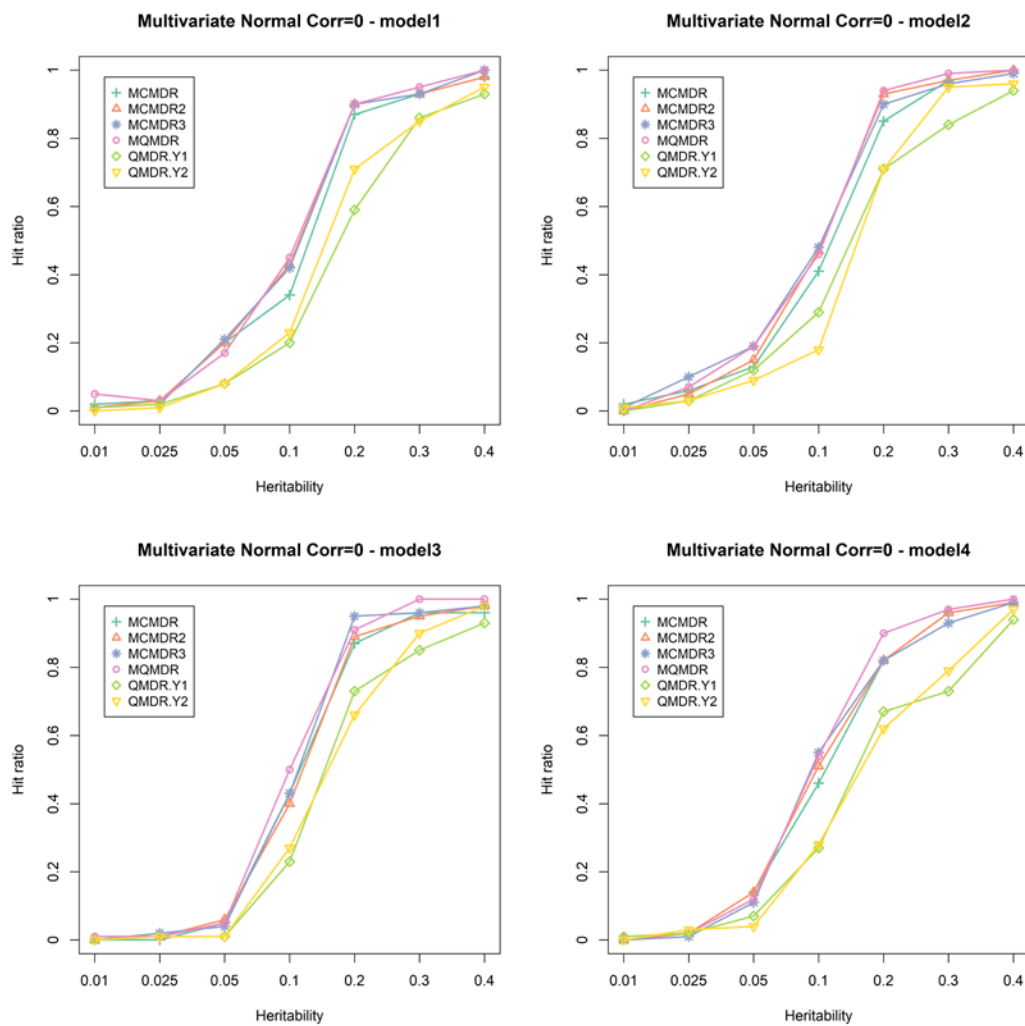
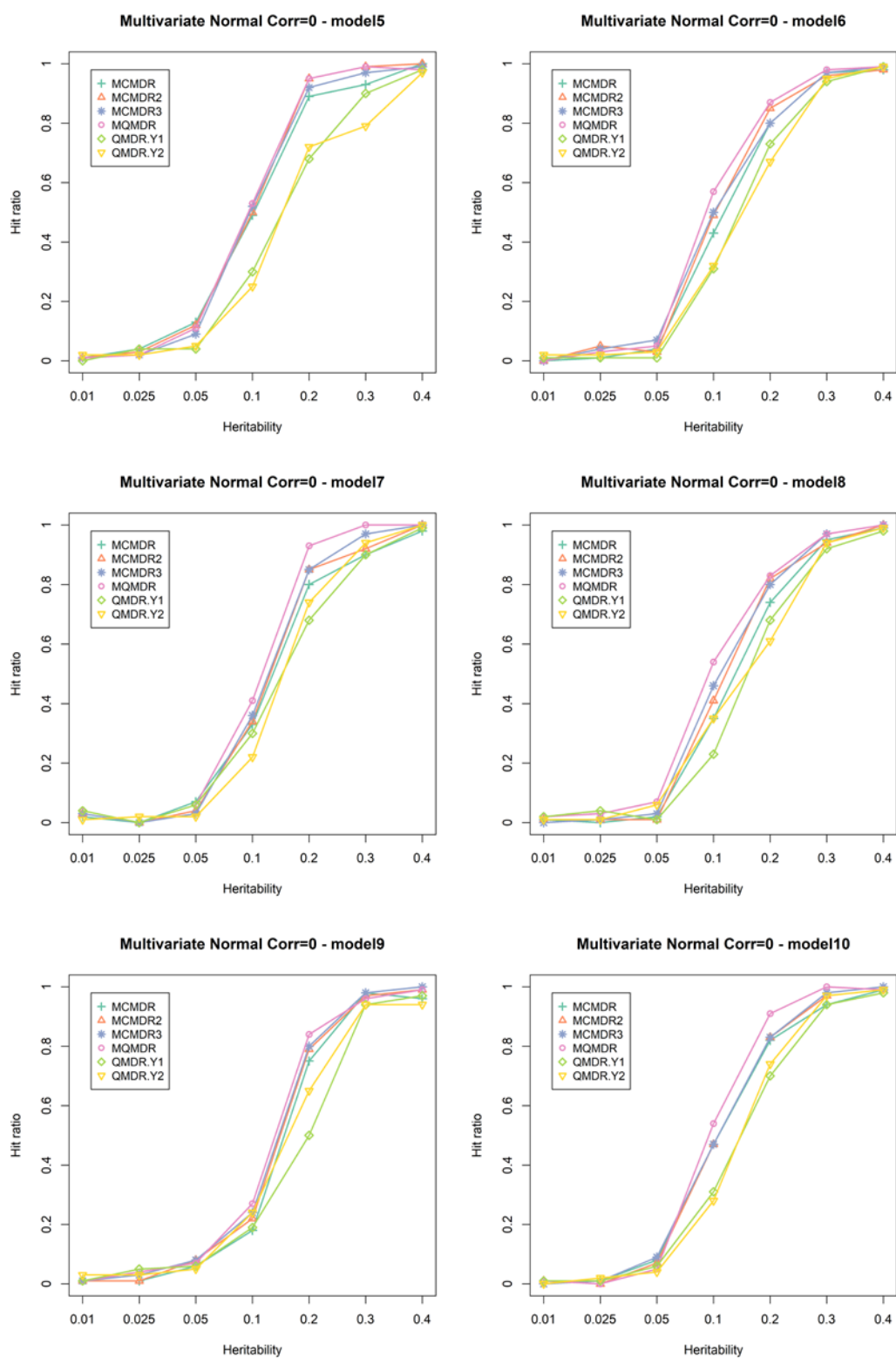


# Supplemental materials

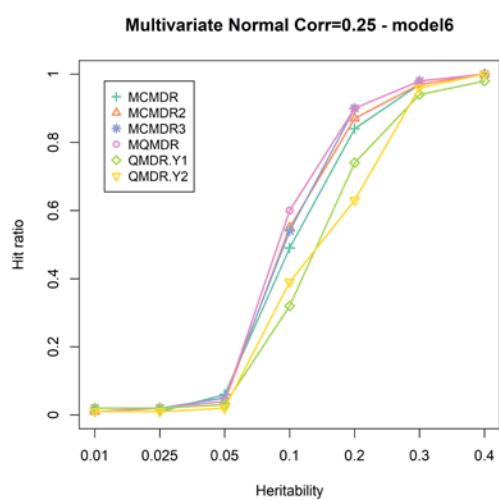
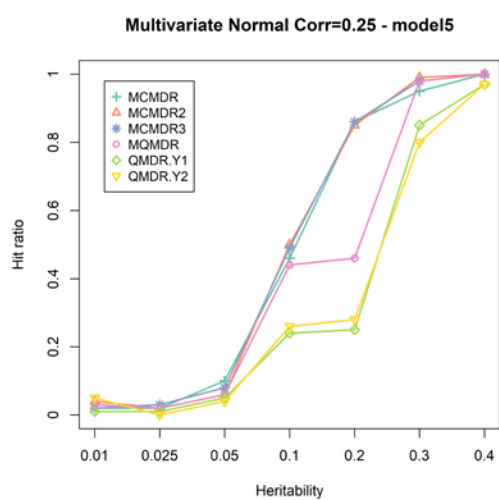
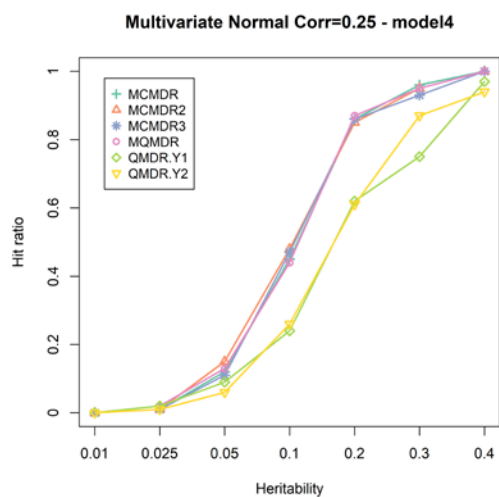
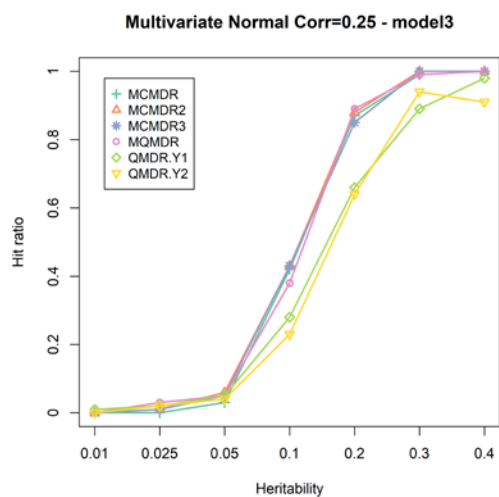
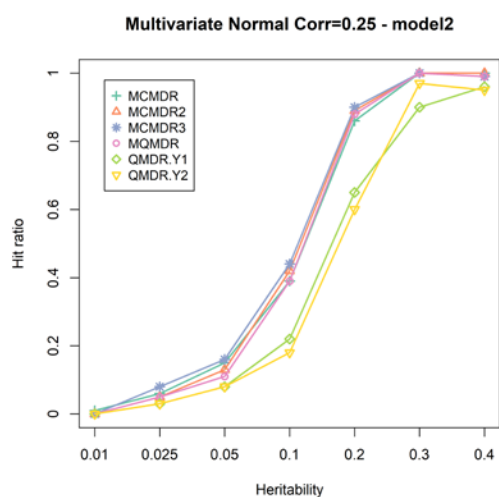
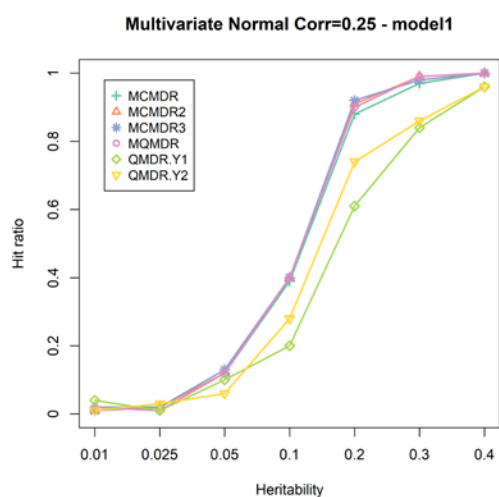
There were 10 combinations of minor allele frequencies (MAFs), and 5 models for each simulation setup. The MAF was 0.2, up to model 5. From models 6 to 10, the MAF was 0.4. We also considered correlation values of 0, 0.25, and 0.5. CMDR (multi-CMDR), MCMDR2 (multi-CMDR without trimming), MCMDR3 (multi-CMDR without membership score), MQMDR (multi-QMDR), QMDR. Y1 (QMDR with  $Y_1$ ), and QMDR Y2 (QMDR with  $Y_2$ )

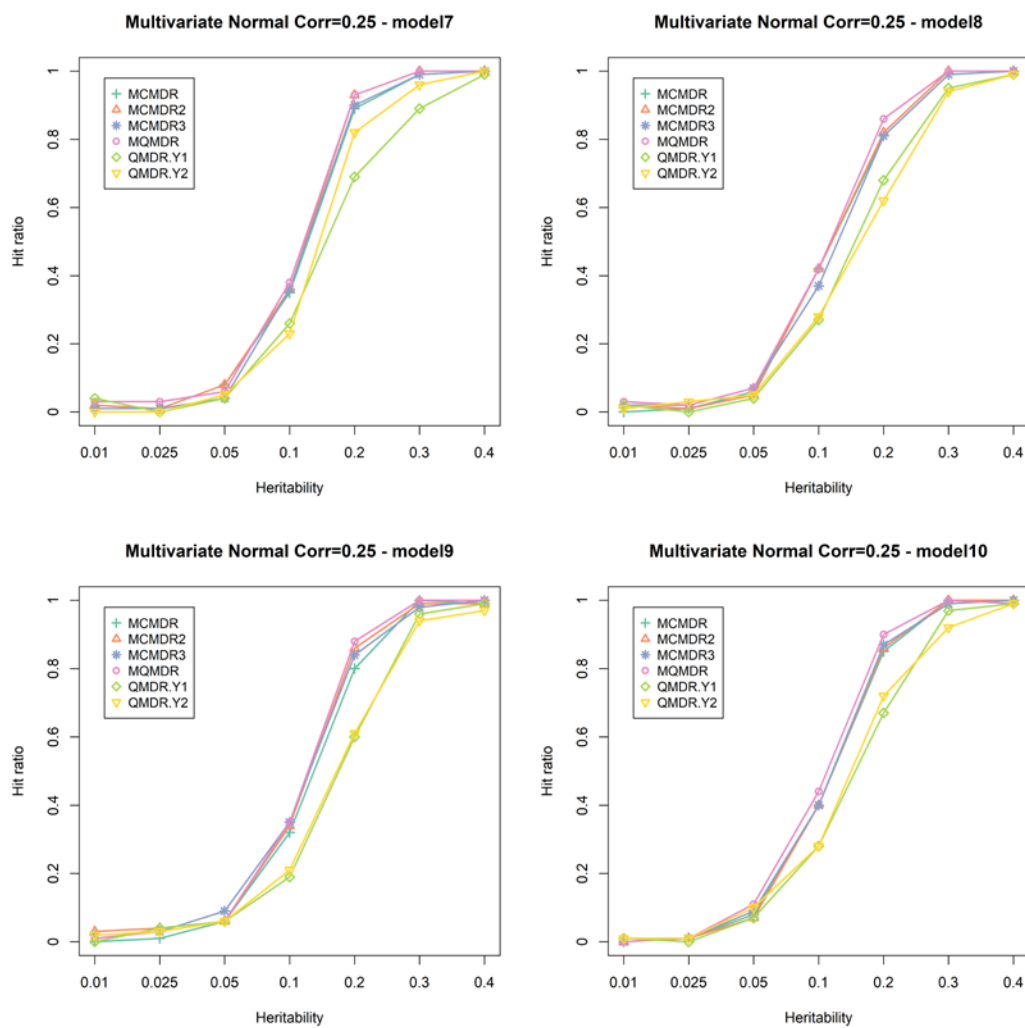
## Multivariate Normal Distributions



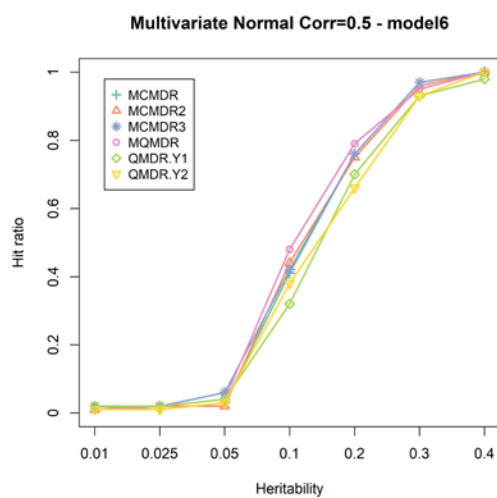
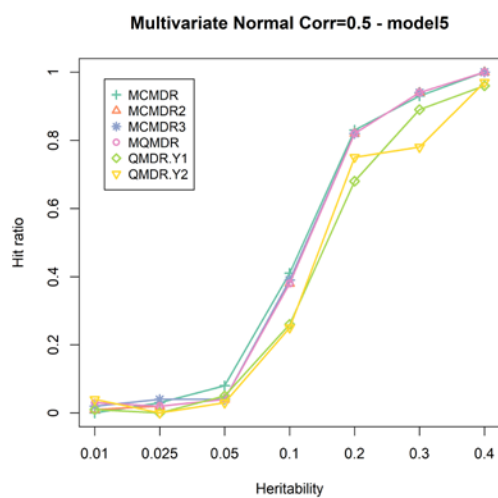
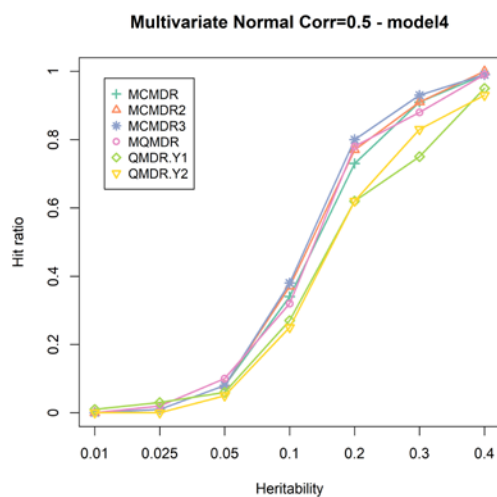
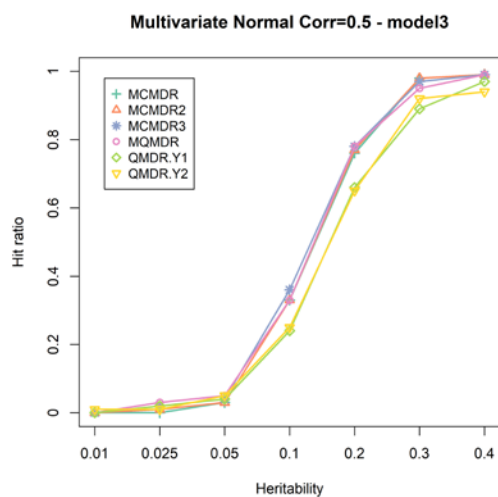
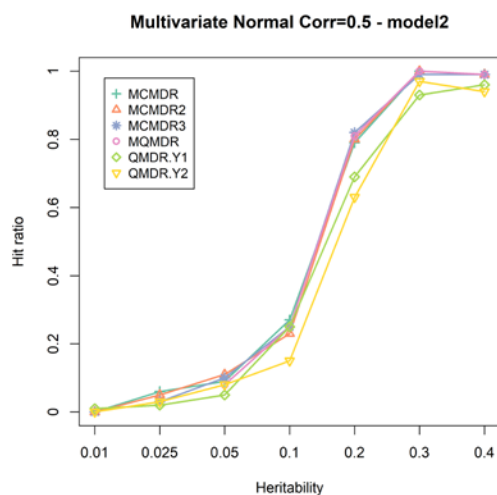
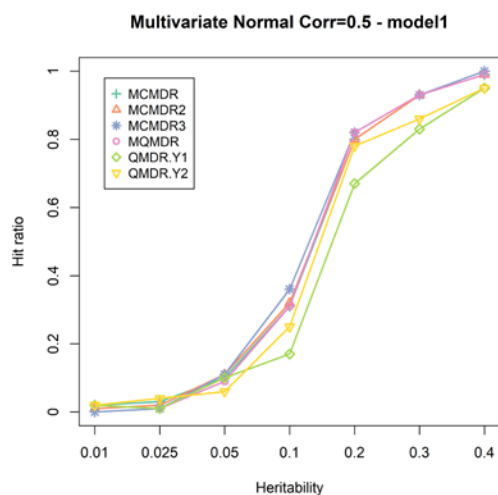


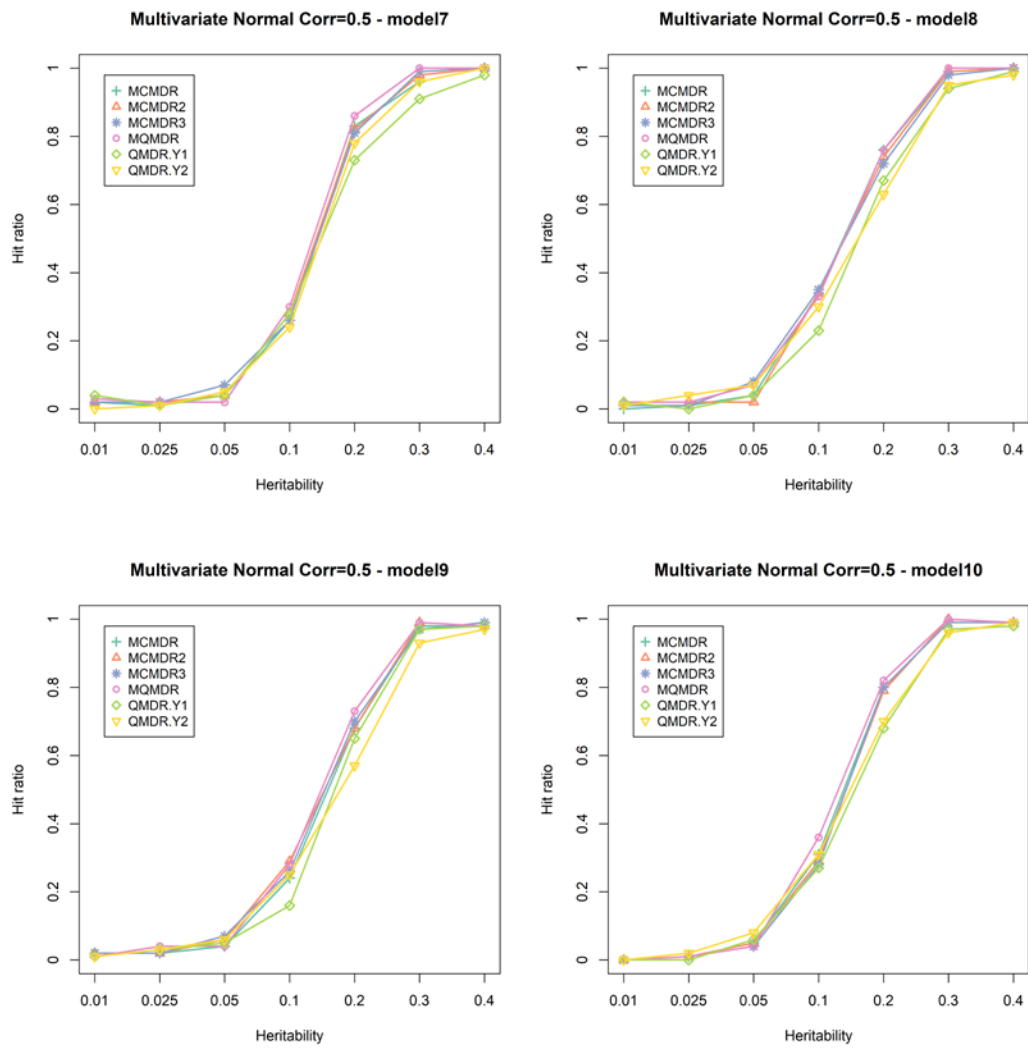
**Supplemental Figure 1.** Hit-ratios for multivariate normal distributions with zero correlation, for 10 models.





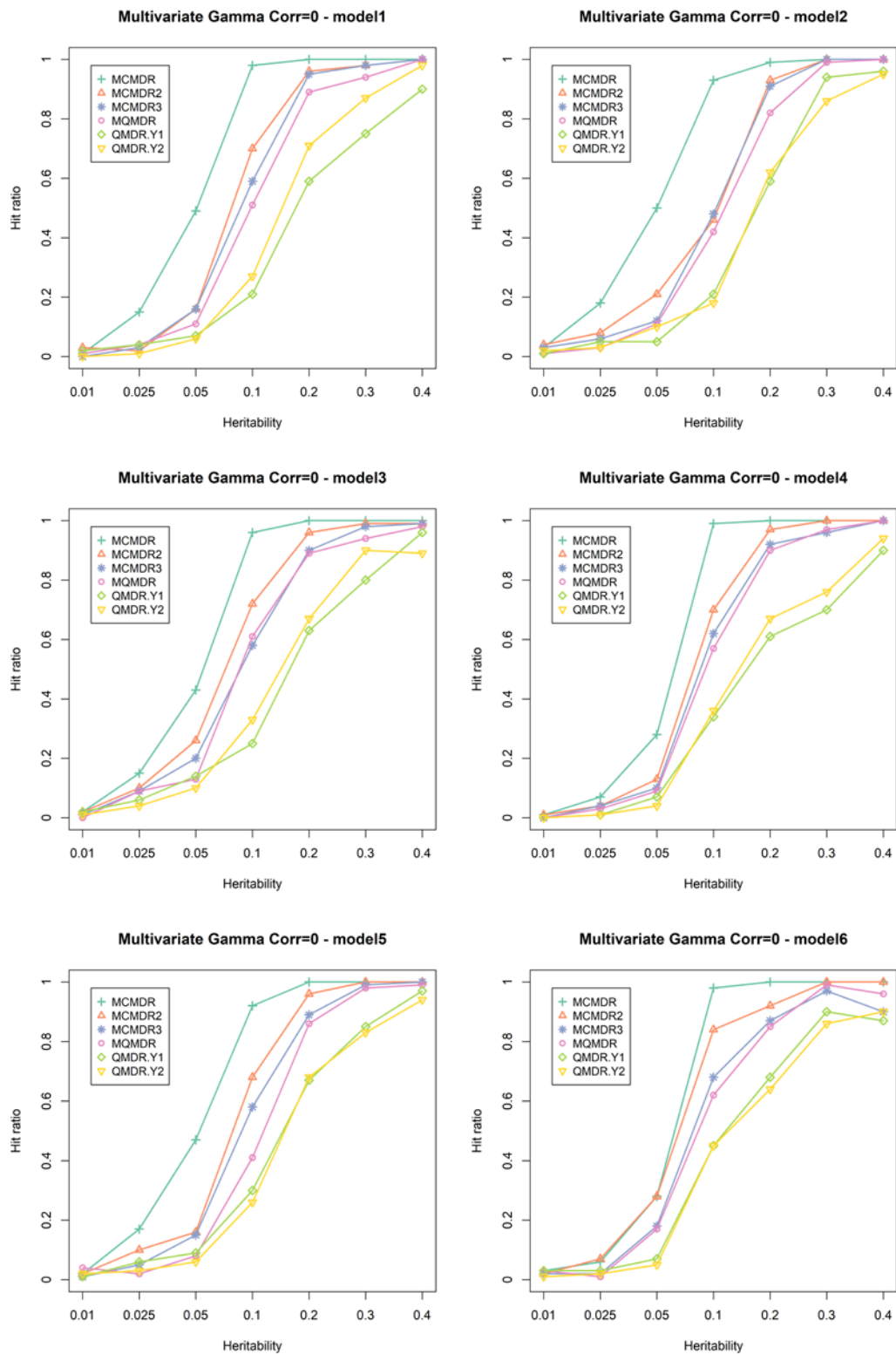
**Supplemental Figure 2.** Hit-ratios for multivariate normal distributions with correlation 0.25, for 10 models.

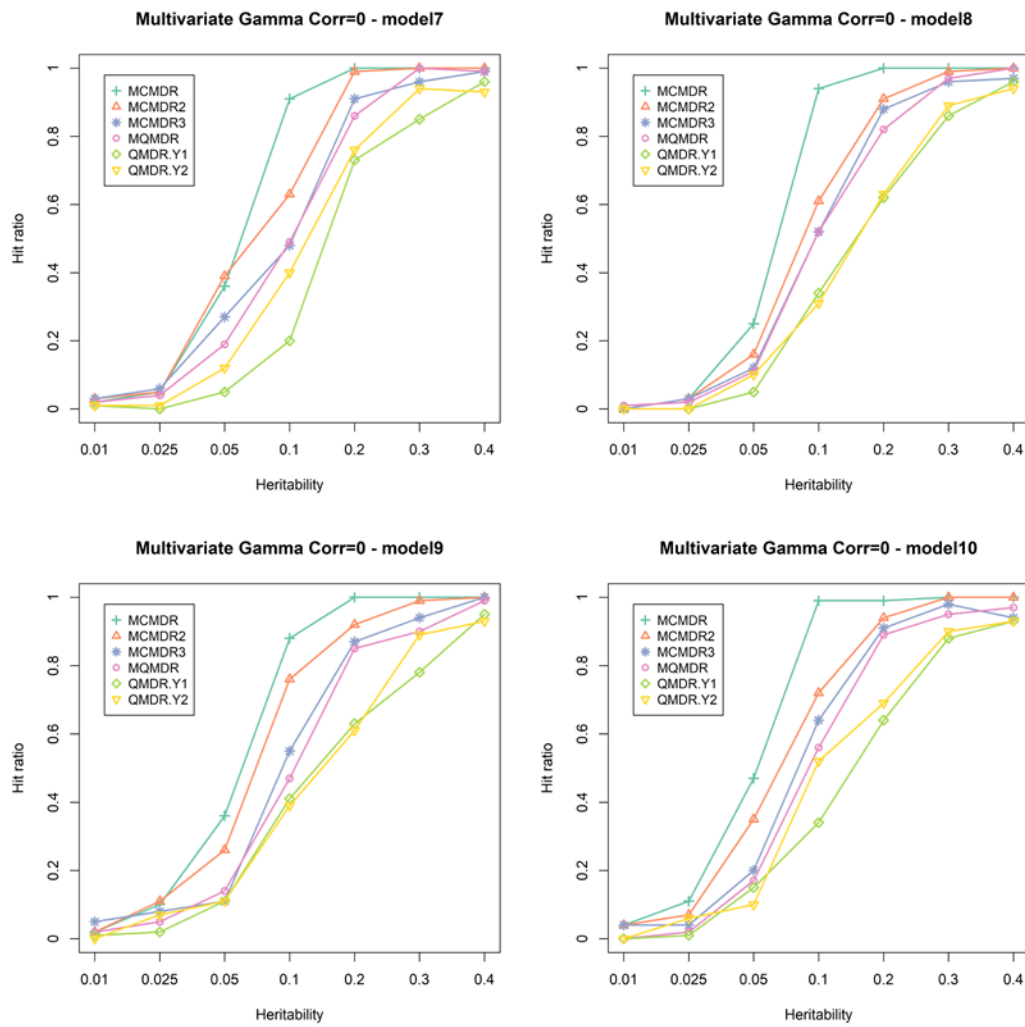




**Supplemental Figure 3.** Hit-ratios for multivariate normal distribution with correlation 0.5 for 10 models

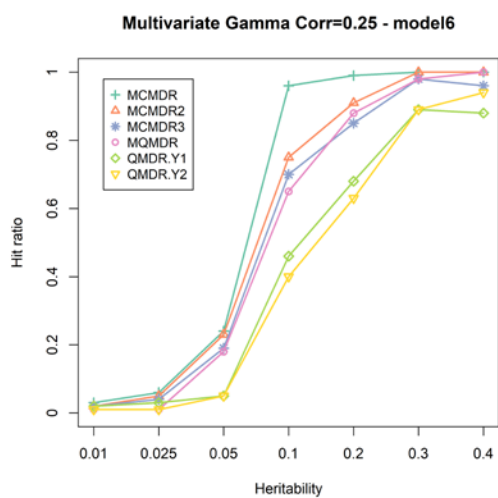
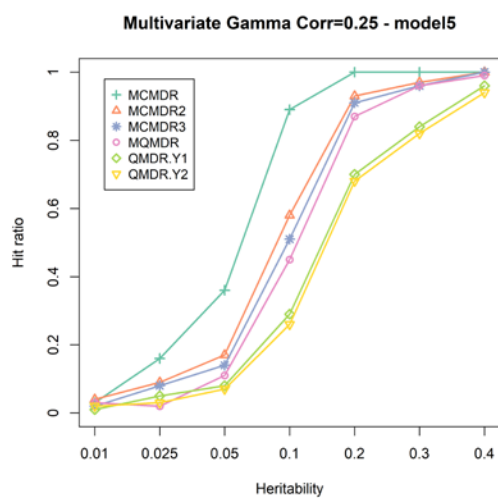
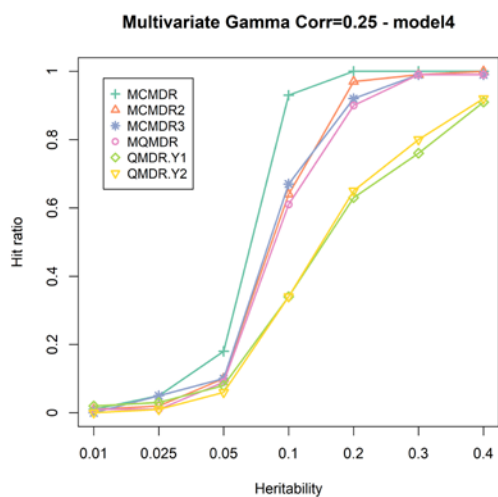
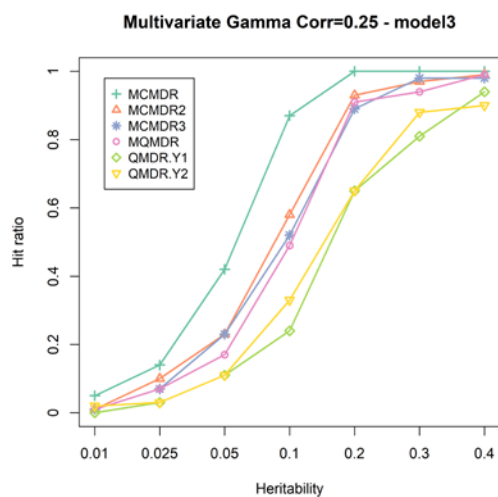
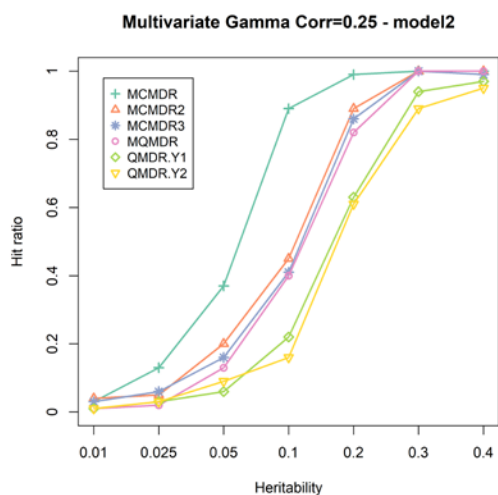
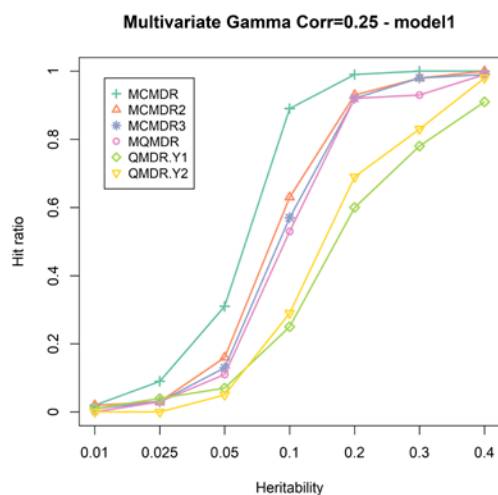
# Multivariate Gamma Distribution

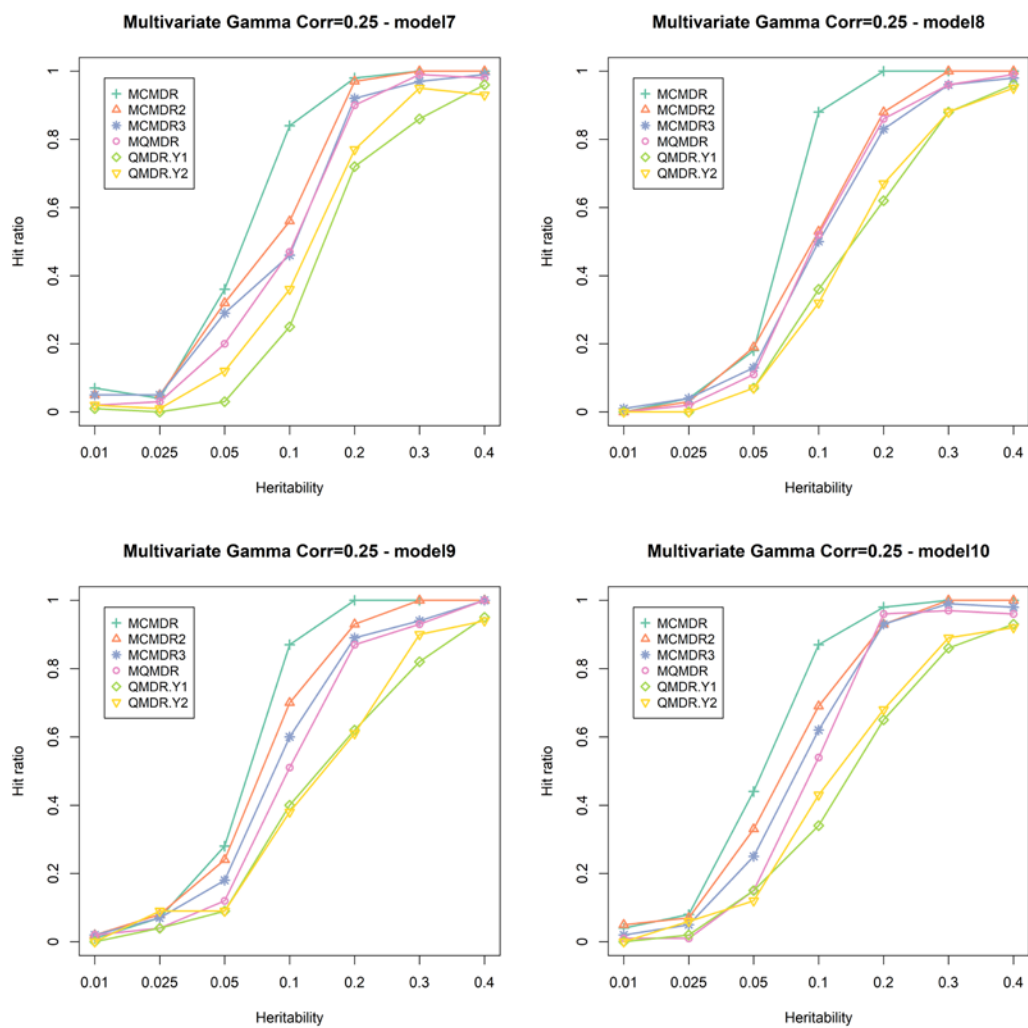




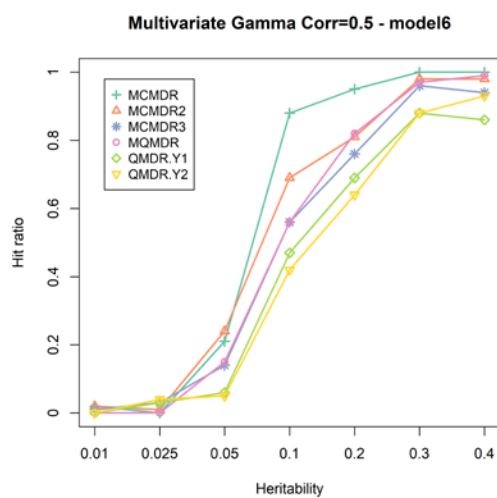
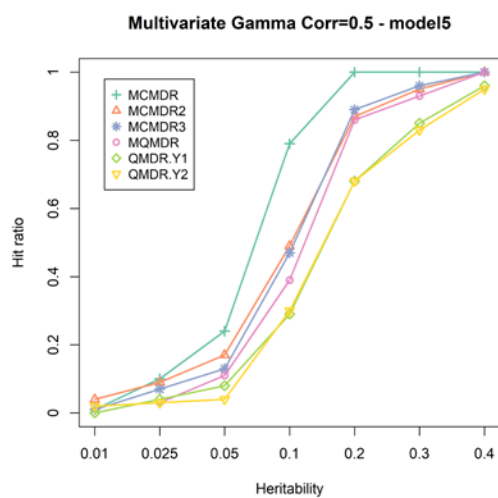
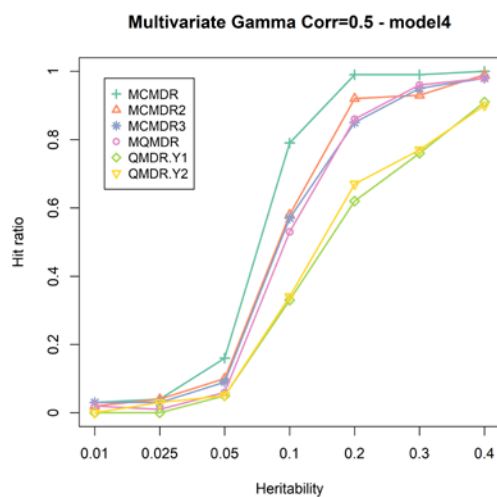
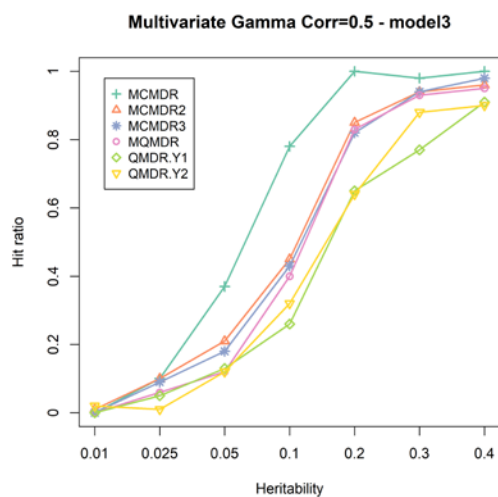
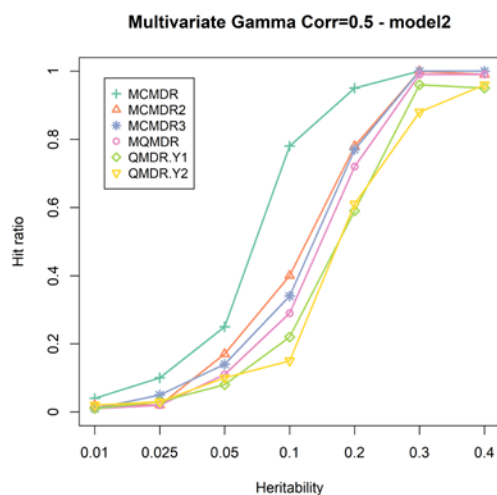
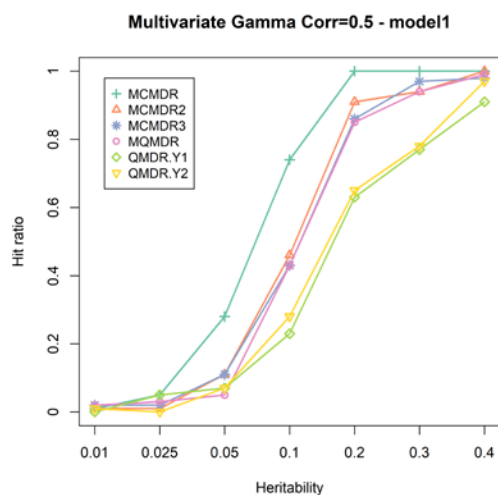
**Supplemental Figure 4.** Hit-ratios for multivariate gamma distributions, with zero correlation, for 10 models.

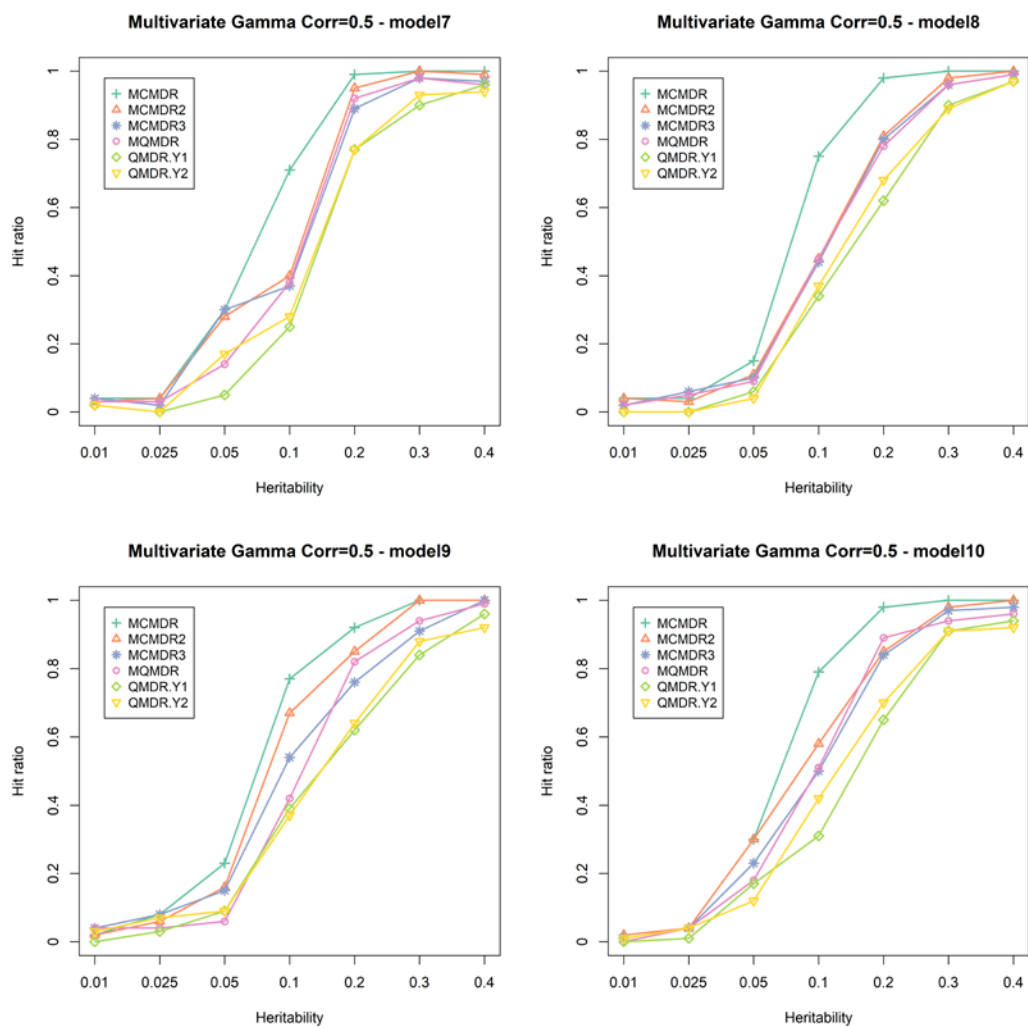






**Supplemental Figure 5.** Hit-ratios for multivariate gamma distributions, with correlation 0.25, for 10 models.





**Supplemental Figure 6.** Hit-ratios for multivariate gamma distributions, with correlation 0.5, for 10 models.

## Multivariate normal distribution

	MCMDR1	MCMDR2	MCMDR3	MQMDR	QMDR.Y1	QMDR.Y2
<b>HET:0.01</b>	0.005	0.003	0.007	0.004	0.005	0.005
<b>HET:0.025</b>	0.005	0.007	0.006	0.005	0.007	0.004
<b>HET:0.05</b>	0.005	0.007	0.006	0.008	0.01	0.012
<b>HET:0.1</b>	0.004	0.002	0.002	0.004	0.005	0.005
<b>HET:0.2</b>	0.005	0.004	0.005	0.006	0.004	0.011
<b>HET:0.3</b>	0.009	0.005	0.005	0.007	0.003	0.007
<b>HET:0.4</b>	0.005	0.008	0.003	0.005	0.008	0.006

**Supplemental Table 1.** Empirical false positive rate for multivariate normal distributions with zero correlation

	MCMDR1	MCMDR2	MCMDR3	MQMDR	QMDR.Y1	QMDR.Y2
<b>HET:0.01</b>	0.006	0.001	0.004	0.006	0.003	0.006
<b>HET:0.025</b>	0.003	0.002	0.008	0.004	0.007	0.006
<b>HET:0.05</b>	0.008	0.011	0.012	0.006	0.008	0.009
<b>HET:0.1</b>	0.005	0.007	0.007	0.003	0.003	0.008
<b>HET:0.2</b>	0.005	0.004	0.004	0.008	0.005	0.005
<b>HET:0.3</b>	0.006	0.008	0.006	0.006	0.003	0.005
<b>HET:0.4</b>	0.004	0.005	0.01	0.006	0.005	0.005

**Supplemental Table 2.** Empirical false positive rate for multivariate normal distributions with correlation 0.25

	MCMDR1	MCMDR2	MCMDR3	MQMDR	QMDR.Y1	QMDR.Y2
<b>HET:0.01</b>	0.006	0.003	0.003	0.002	0.003	0.003
<b>HET:0.025</b>	0.003	0.001	0.006	0.003	0.007	0.004
<b>HET:0.05</b>	0.01	0.01	0.012	0.009	0.006	0.005
<b>HET:0.1</b>	0.003	0.004	0.003	0.003	0.004	0.005
<b>HET:0.2</b>	0.006	0.003	0.006	0.008	0.006	0.006
<b>HET:0.3</b>	0.007	0.008	0.006	0.007	0.006	0.005
<b>HET:0.4</b>	0.005	0.004	0.005	0.006	0.004	0.002

**Supplemental Table 3.** Empirical false positive rate for multivariate normal distributions with correlation 0.5

## Multivariate gamma distribution

	MCMDR1	MCMDR2	MCMDR3	MQMDR	QMDR.Y1	QMDR.Y2
<b>HET:0.01</b>	0.007	0.003	0.008	0.003	0.005	0.001
<b>HET:0.025</b>	0.004	0.005	0.003	0.005	0.008	0.003
<b>HET:0.05</b>	0.008	0.007	0.005	0.008	0.006	0.008
<b>HET:0.1</b>	0.004	0.005	0.003	0.007	0.009	0.002
<b>HET:0.2</b>	0.006	0.006	0.003	0.004	0.008	0.003
<b>HET:0.3</b>	0.002	0.001	0.001	0.002	0.001	0.001
<b>HET:0.4</b>	0.002	0.003	0.003	0.004	0.005	0.009

**Supplemental Table 4.** Empirical false positive rate for multivariate gamma distributions with zero correlation

	MCMDR1	MCMDR2	MCMDR3	MQMDR	QMDR.Y1	QMDR.Y2
<b>HET:0.01</b>	0.005	0.004	0.003	0.006	0.005	0.002
<b>HET:0.025</b>	0.002	0.005	0.002	0.003	0.009	0.002
<b>HET:0.05</b>	0.004	0.007	0.008	0.007	0.007	0.004
<b>HET:0.1</b>	0.006	0.002	0.002	0.008	0.007	0.006
<b>HET:0.2</b>	0.004	0.006	0.003	0.003	0.01	0.002
<b>HET:0.3</b>	0.001	0.001	0.005	0.002	0.002	0
<b>HET:0.4</b>	0.002	0.003	0.008	0.004	0.006	0.006

**Supplemental Table 5.** Empirical false positive rate for multivariate gamma distributions with correlation 0.25

	MCMDR1	MCMDR2	MCMDR3	MQMDR	QMDR.Y1	QMDR.Y2
<b>HET:0.01</b>	0.004	0.003	0.003	0.005	0.001	0.007
<b>HET:0.025</b>	0.005	0.008	0.009	0.01	0.006	0.005
<b>HET:0.05</b>	0.004	0.004	0.007	0.004	0.007	0.004
<b>HET:0.1</b>	0.009	0.006	0.004	0.006	0.006	0.005
<b>HET:0.2</b>	0.005	0.005	0.003	0.004	0.01	0.004
<b>HET:0.3</b>	0.001	0.002	0.005	0.001	0.005	0.002
<b>HET:0.4</b>	0.001	0.004	0.003	0.004	0.005	0.002

**Supplemental Table 6.** Empirical false positive rate for multivariate gamma distributions with correlation 0.5