

Validate Power: d3.2

March 31, 2022

Design: Blocked Cluster RCT, with 3 levels, and randomization done at level 2 (school level).

Models: random and fixed treatment effects.

d_m codes: `d3.2_m3ff2rc`, `d3.2_m3rr2rc`

Default parameters:

- $M = 3$
- $J = 30$
- $K = 10$
- rho: $\rho = 0.5$
- MDES: 0.125, 0.125, 0.125
- R2: $R_1^2 = 0.1, 0.1, 0.1$, $R_2^2 = 0.1, 0.1, 0.1$, $R_3^2 = 0$
- ICC: $ICC_2 = 0.2, 0.2, 0.2$, $ICC_3 = 0.2, 0.2, 0.2$
- Omega2: $\omega_2 = 0$

Parameters by model type:

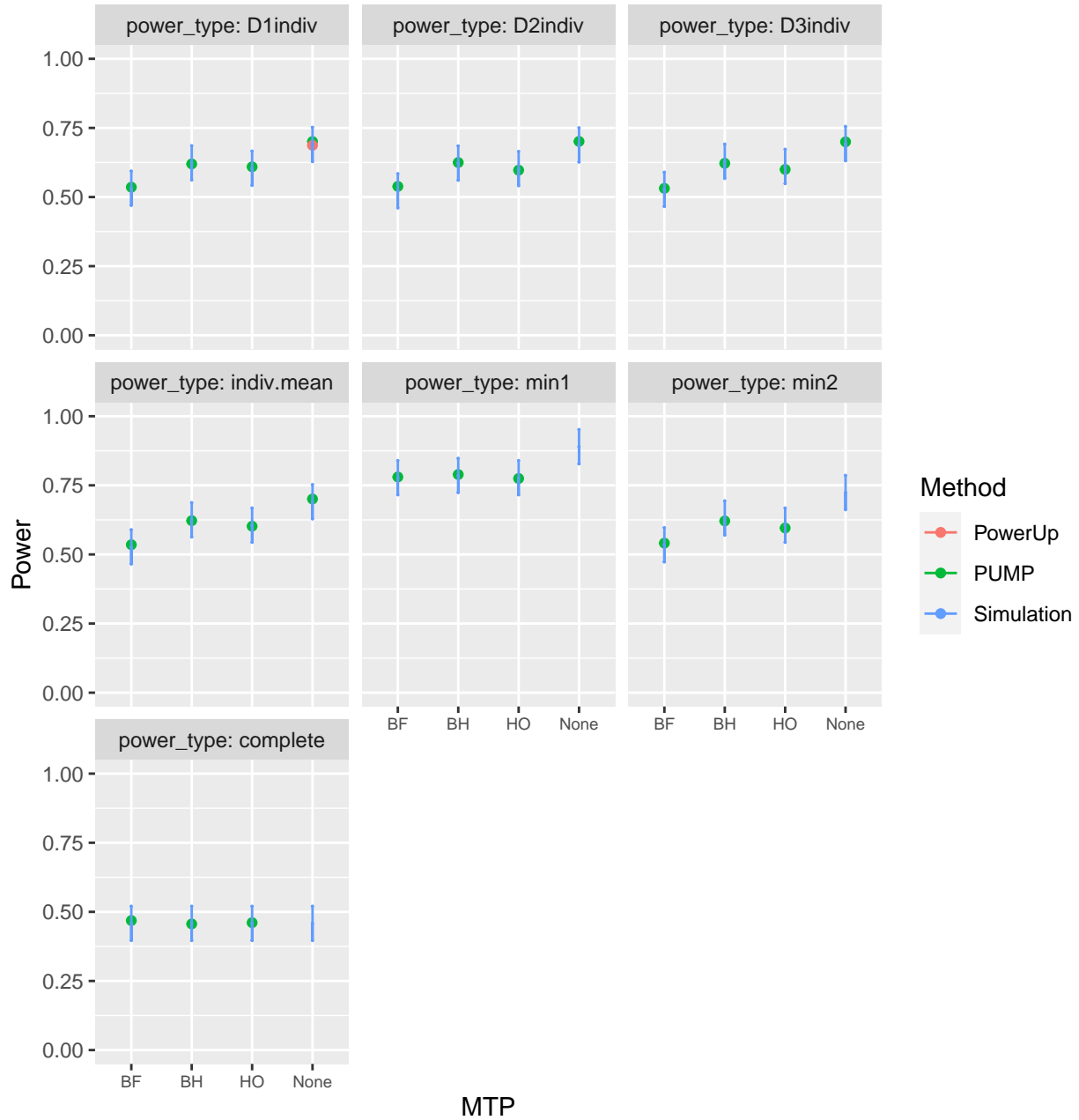
- Omega3: $\omega_3 = 0$ for fixed effects, $\omega_3 = 0.1, 0.1, 0.1$ for random effects

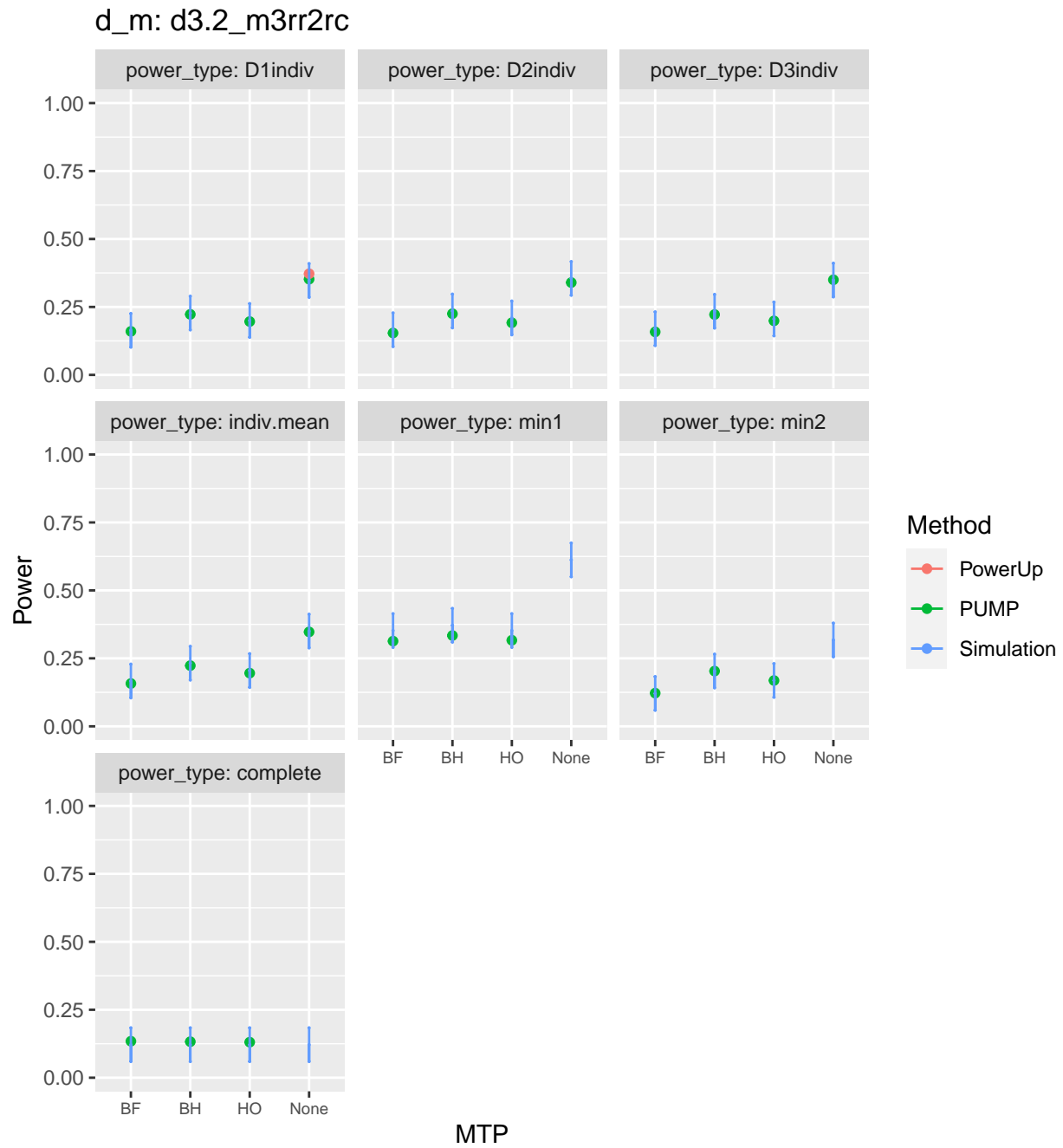
Remark. For some of the scenarios, the PUMP estimate is slightly outside the range of the monte carlo intervals. This occurs for the `d3.2_m3rr2rc` model when either $\omega_3 = 0$ or $ICC.3 = 0$. In general, we find that this model is difficult to fit. Across all scenarios, many of the simulated datasets result in either models that do not converge, or have a singular fit. We believe that the poor-fitting model is exacerbated when there is no truly variation at level 3 (due to $\omega_3 = 0$ or $ICC.3 = 0$), but the model is attempting to fit random effects to the treatment impacts. The poor-fitting models may result in the simulations not achieve accurate estimates of power.

Power Validation

Base case

d_m: d3.2_m3ff2rc

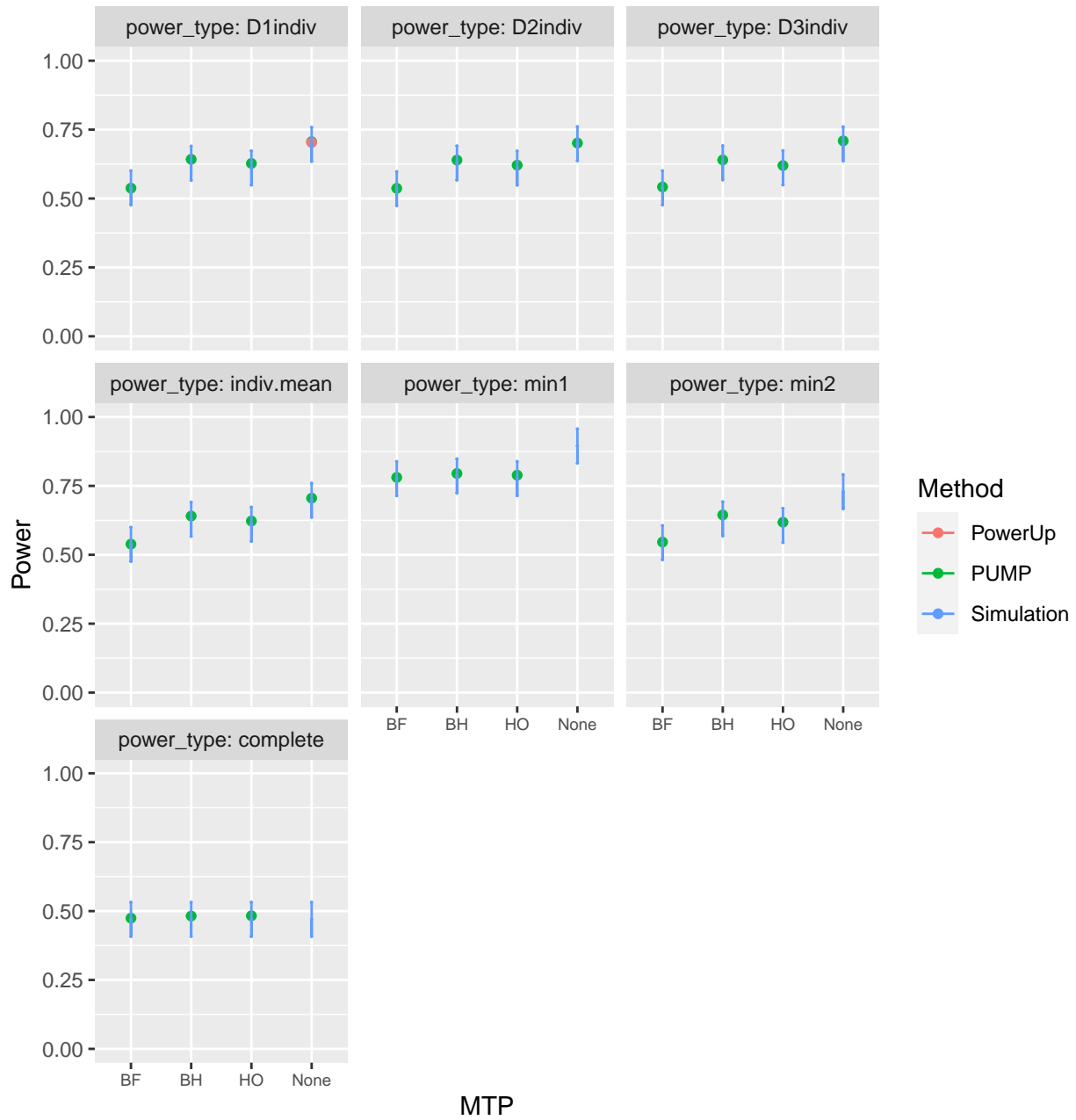


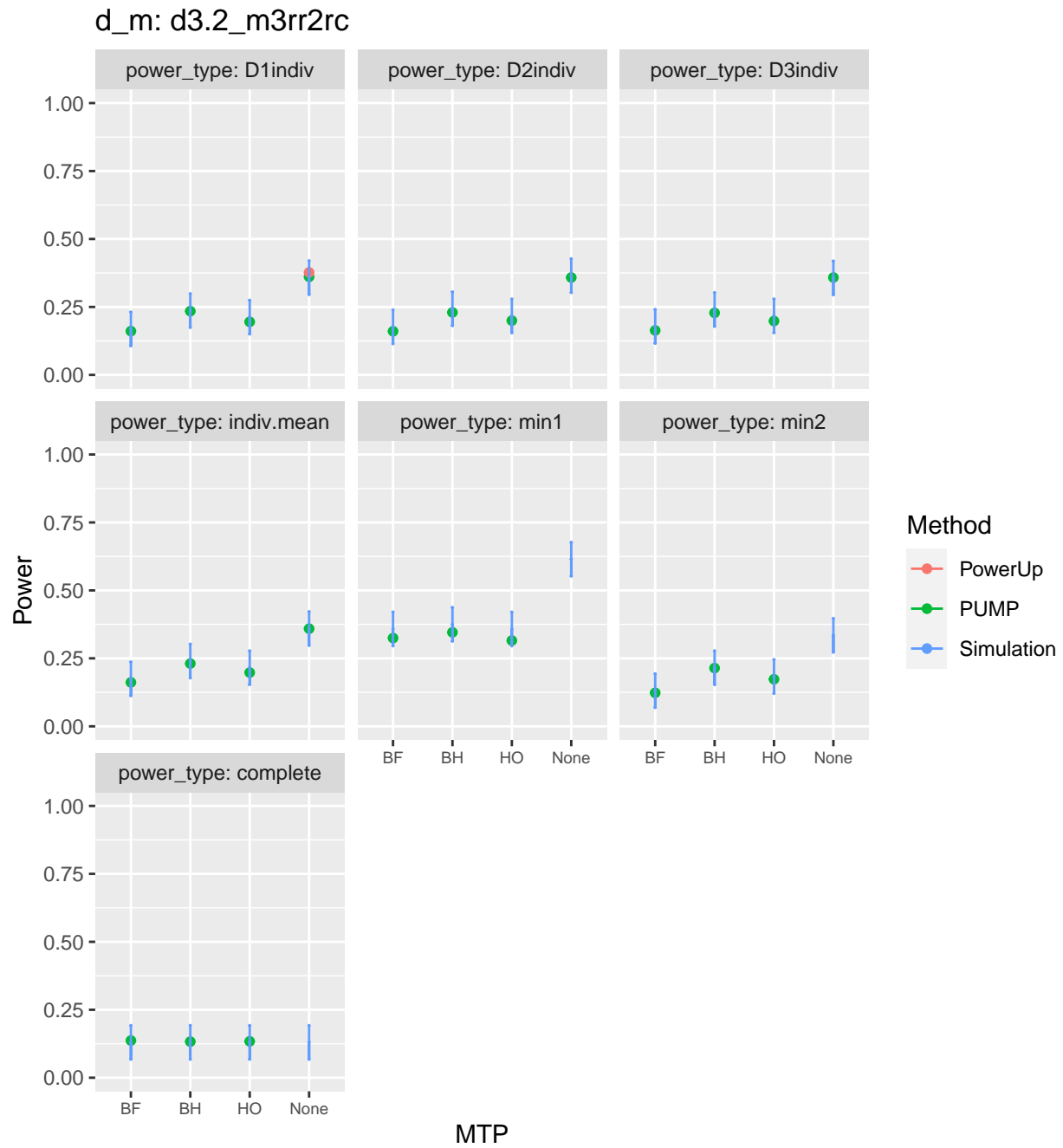


Varying school size

$\bar{n} = 100$

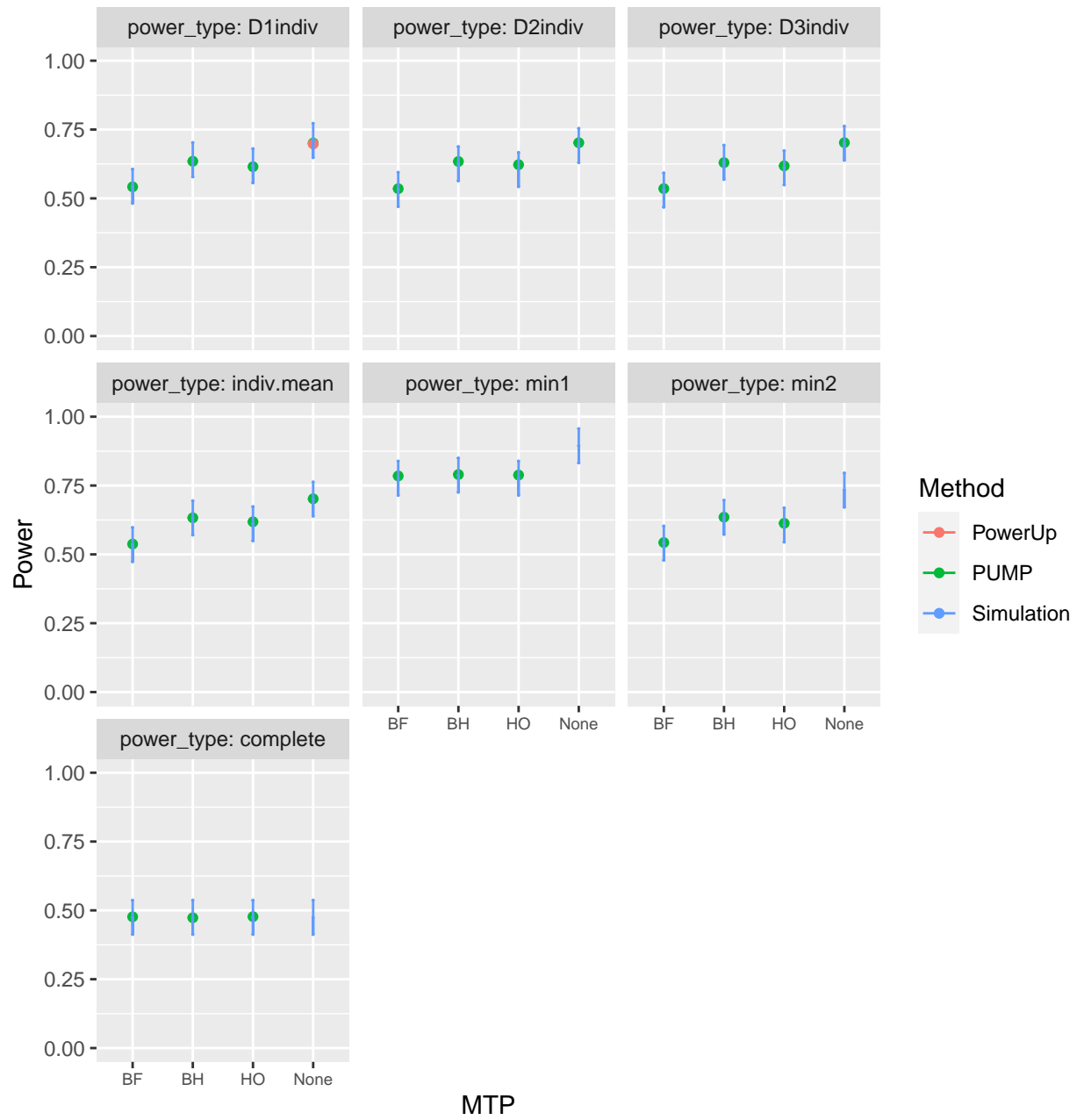
d_m: d3.2_m3ff2rc

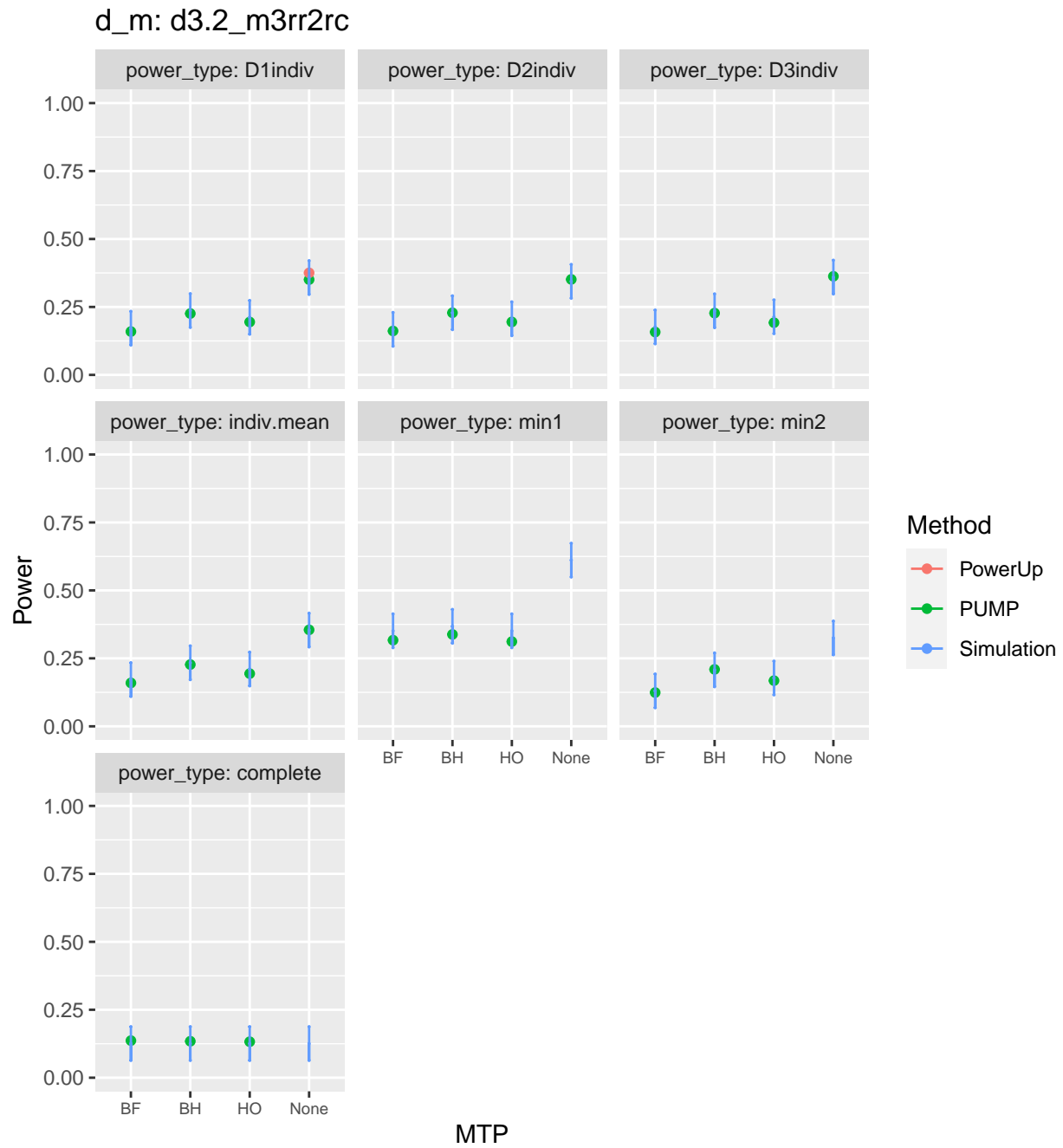




$\bar{n} = 75$

d_m: d3.2_m3ff2rc

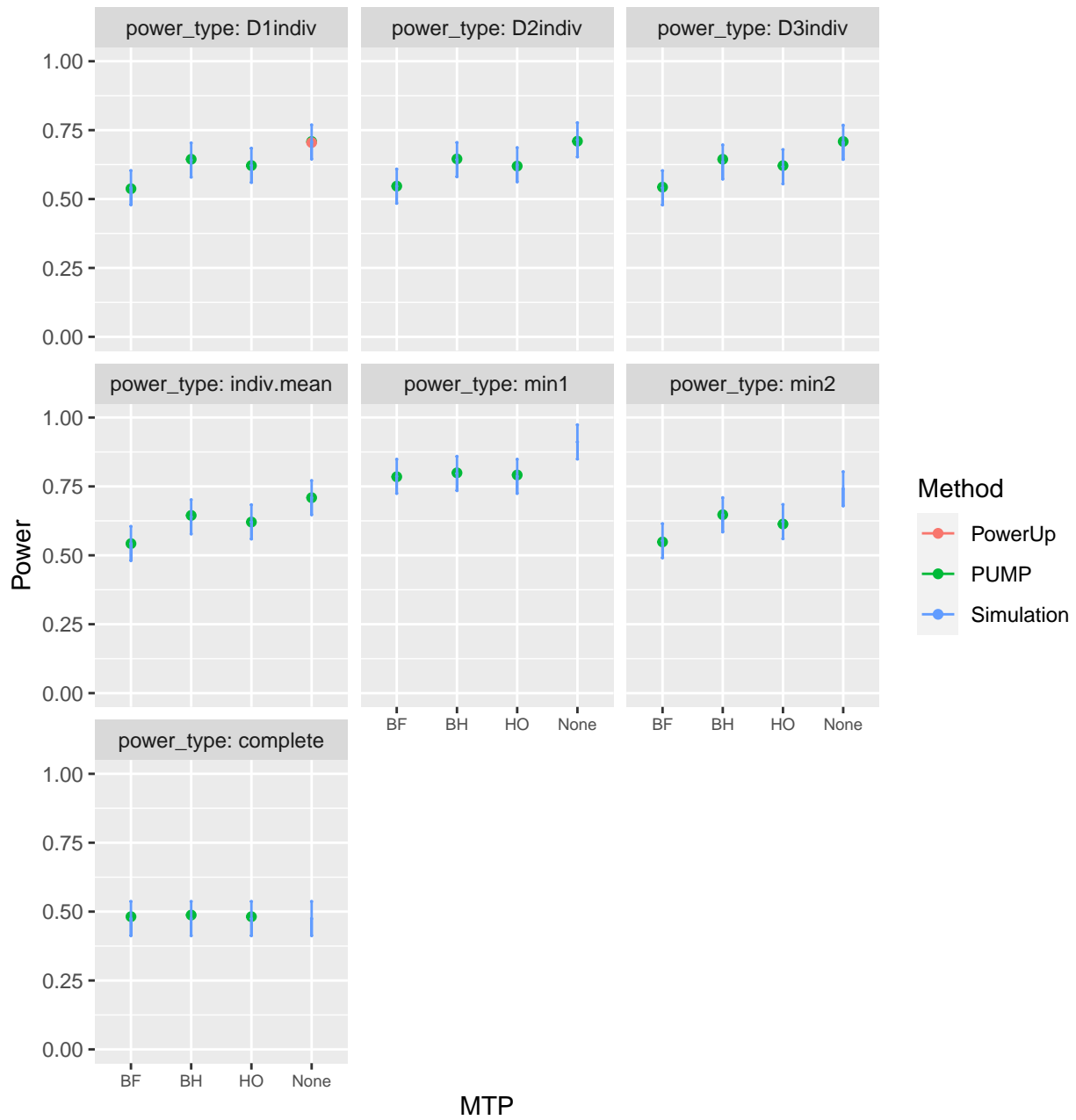




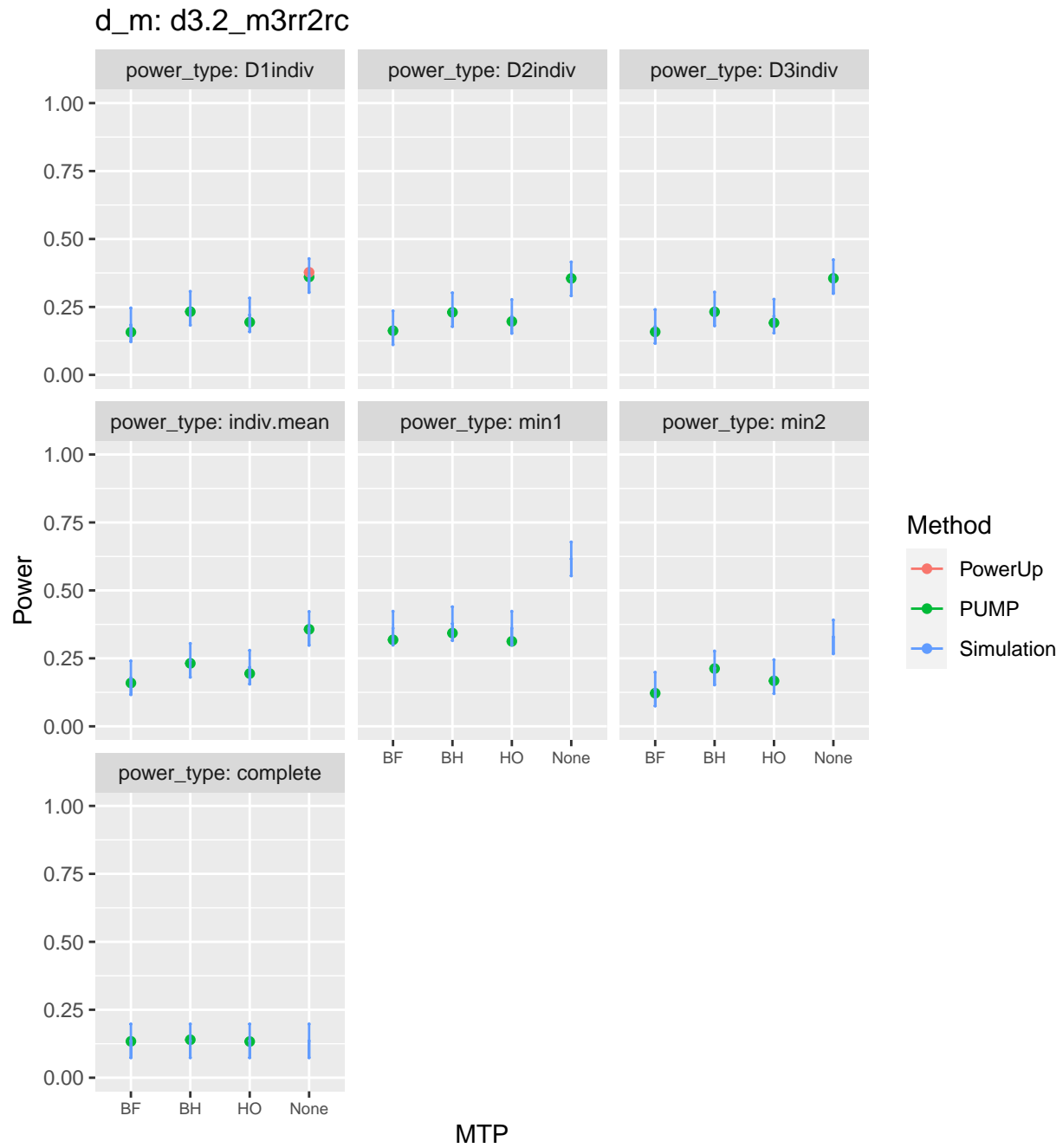
Varying R2

$$R_1^2 = 0.6, 0.6, 0.6$$

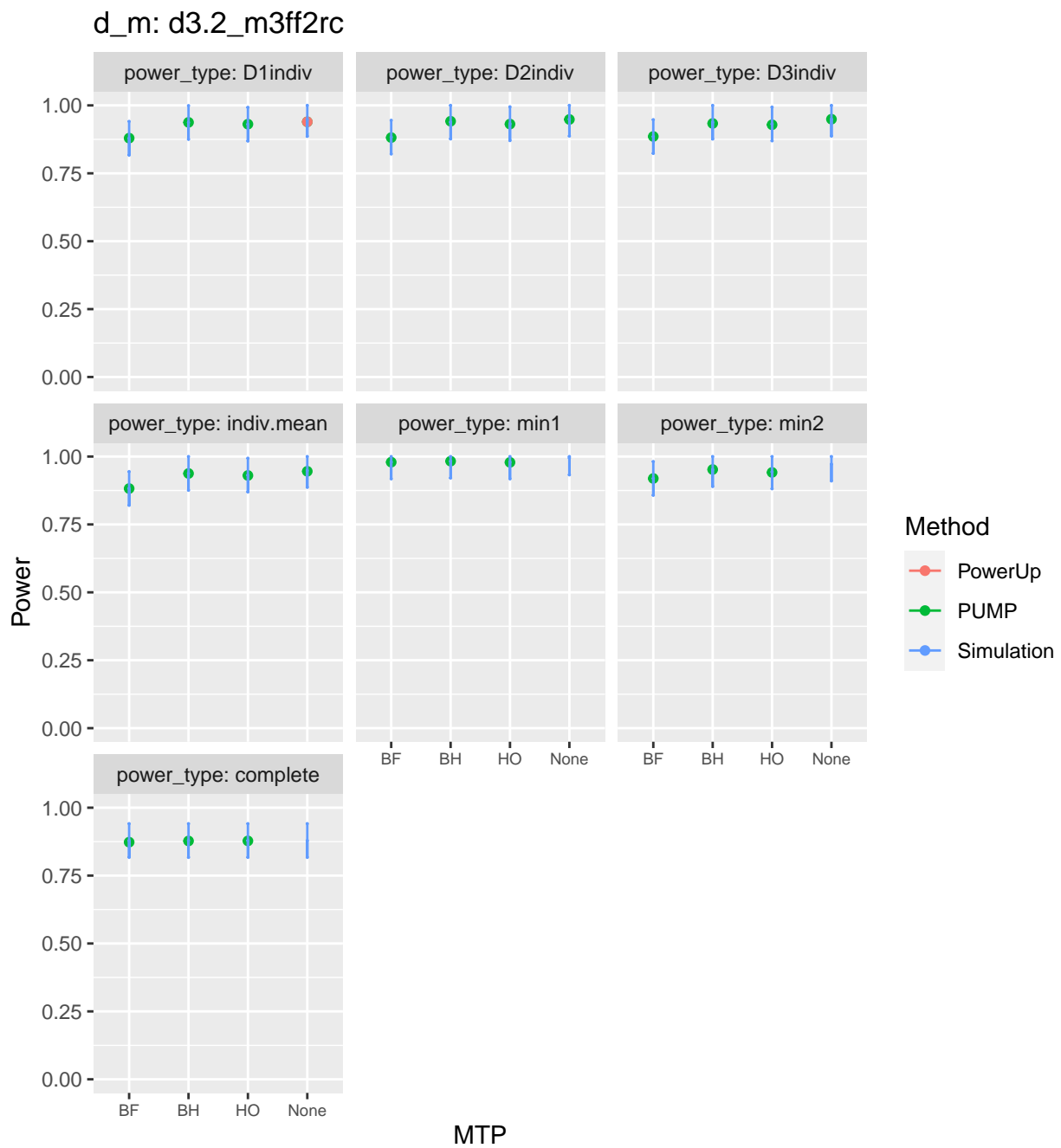
d_m: d3.2_m3ff2rc

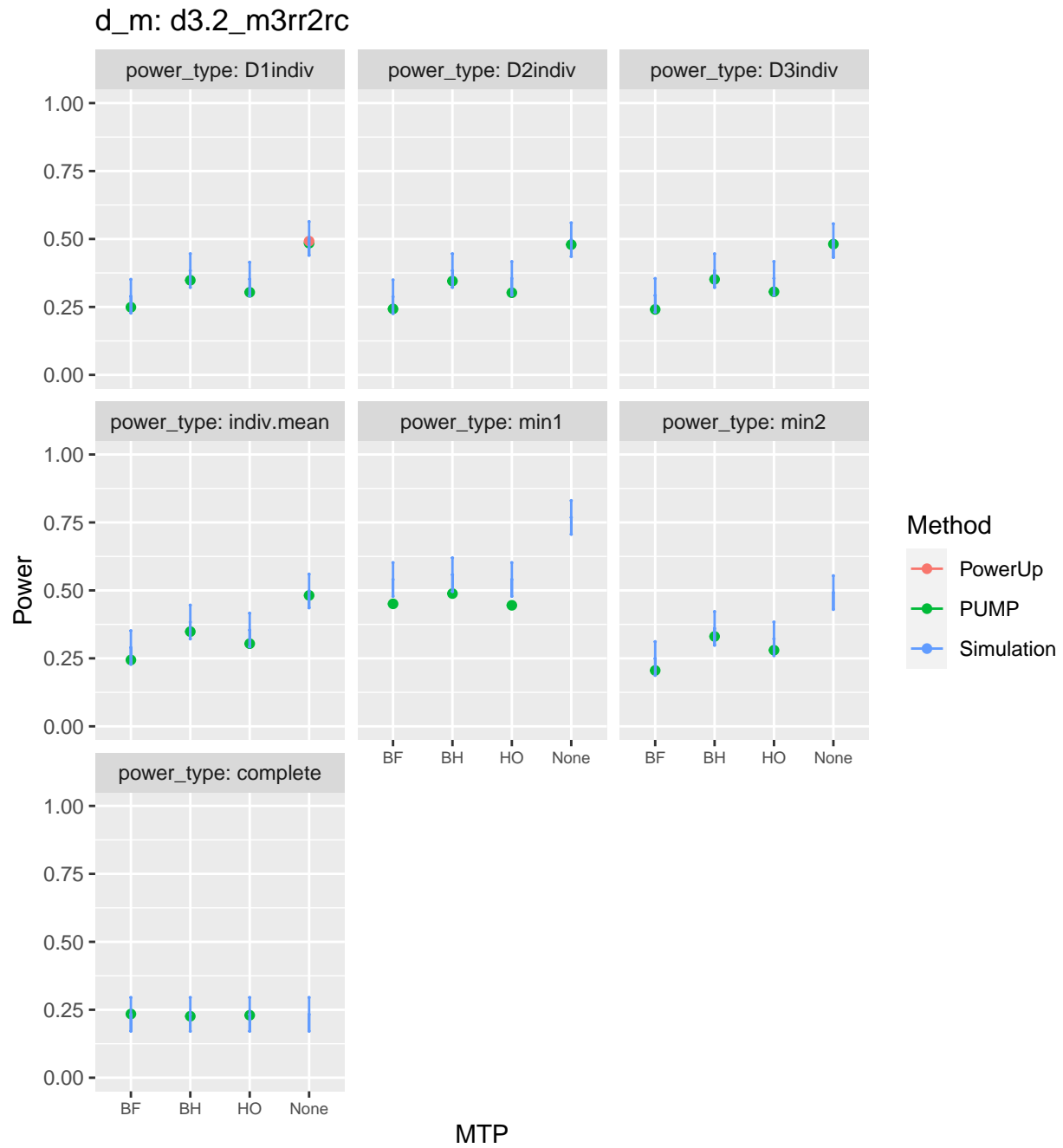


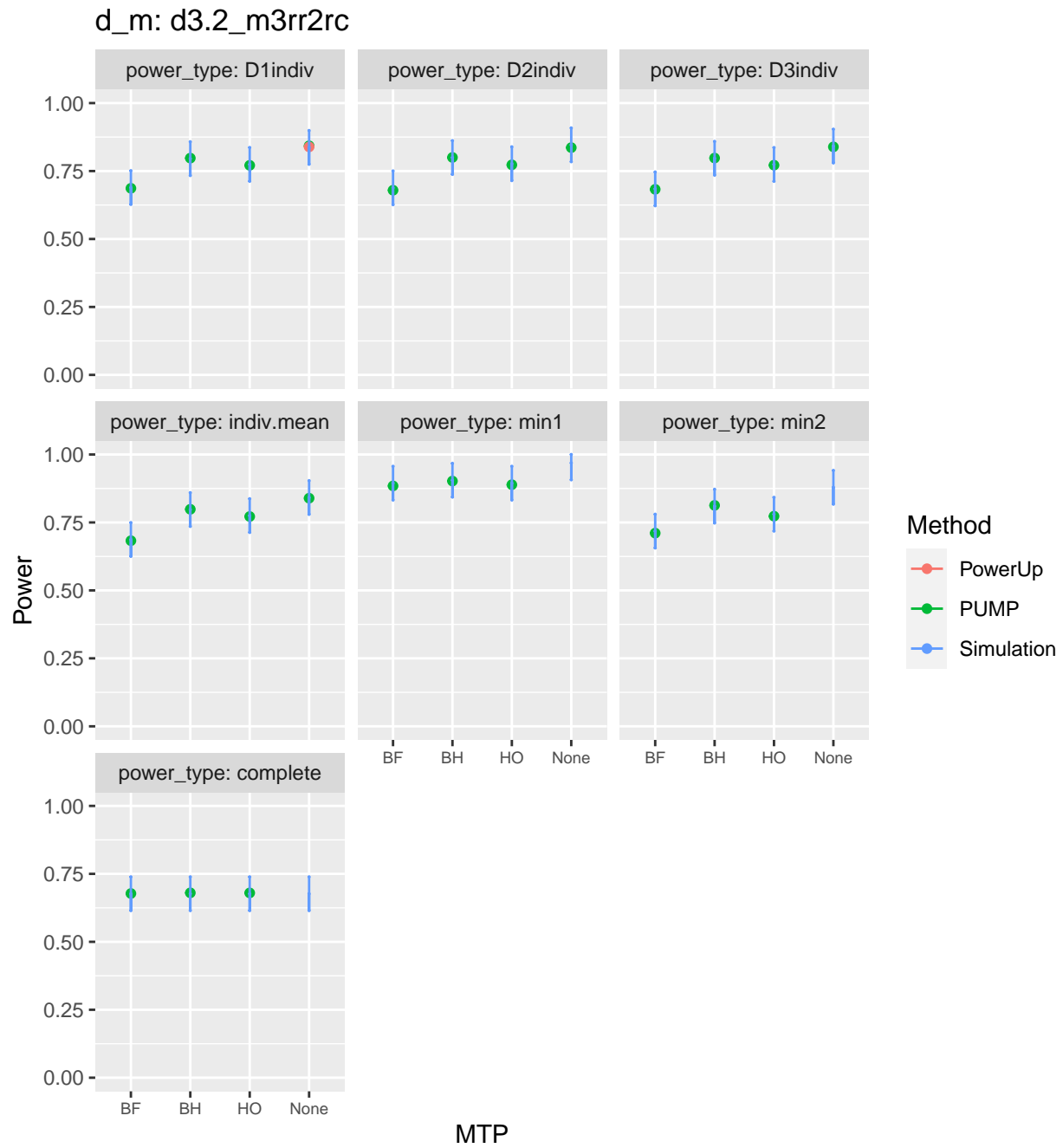
MTP

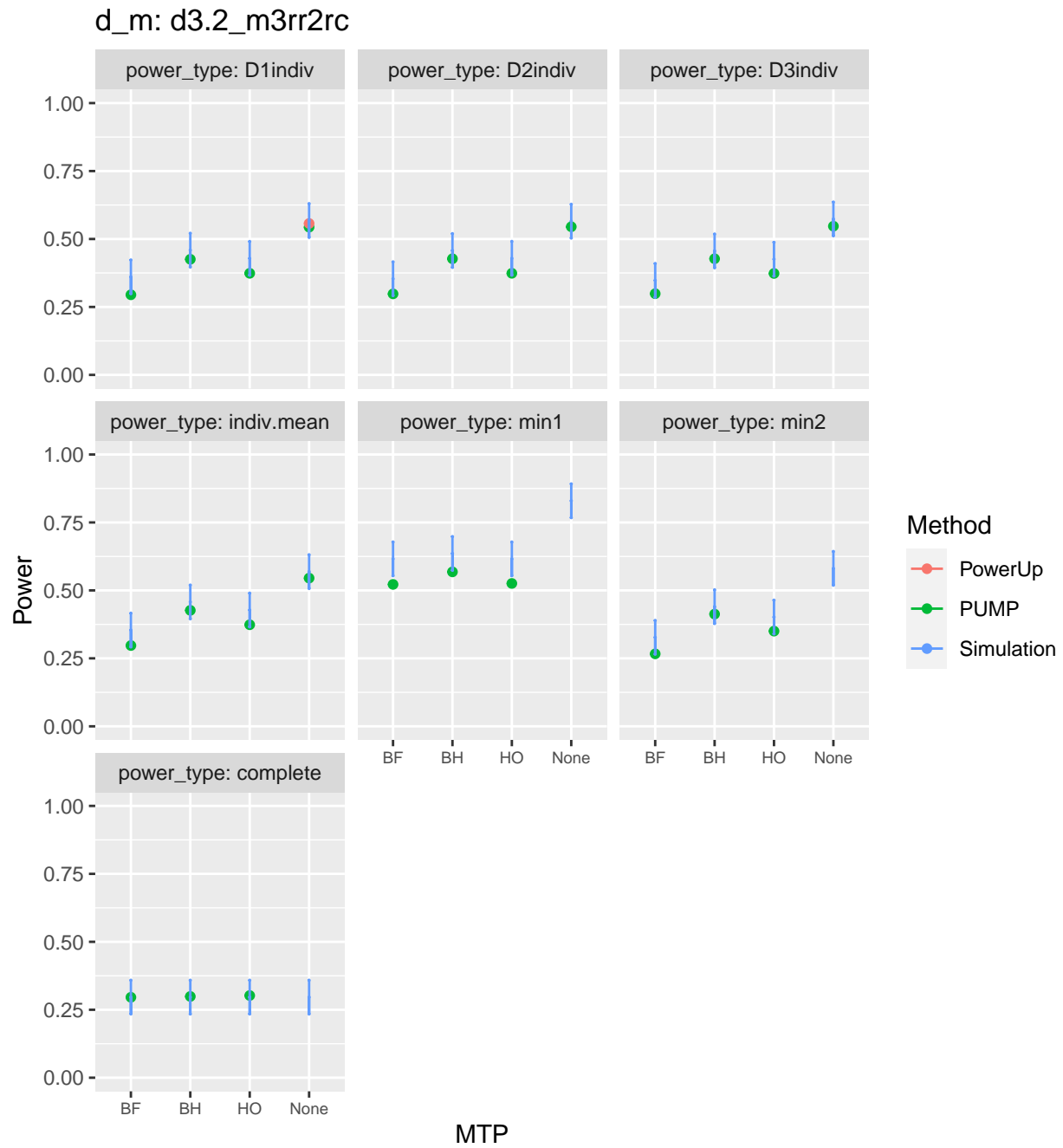


$$R_2^2 = 0.6, 0.6, 0.6$$



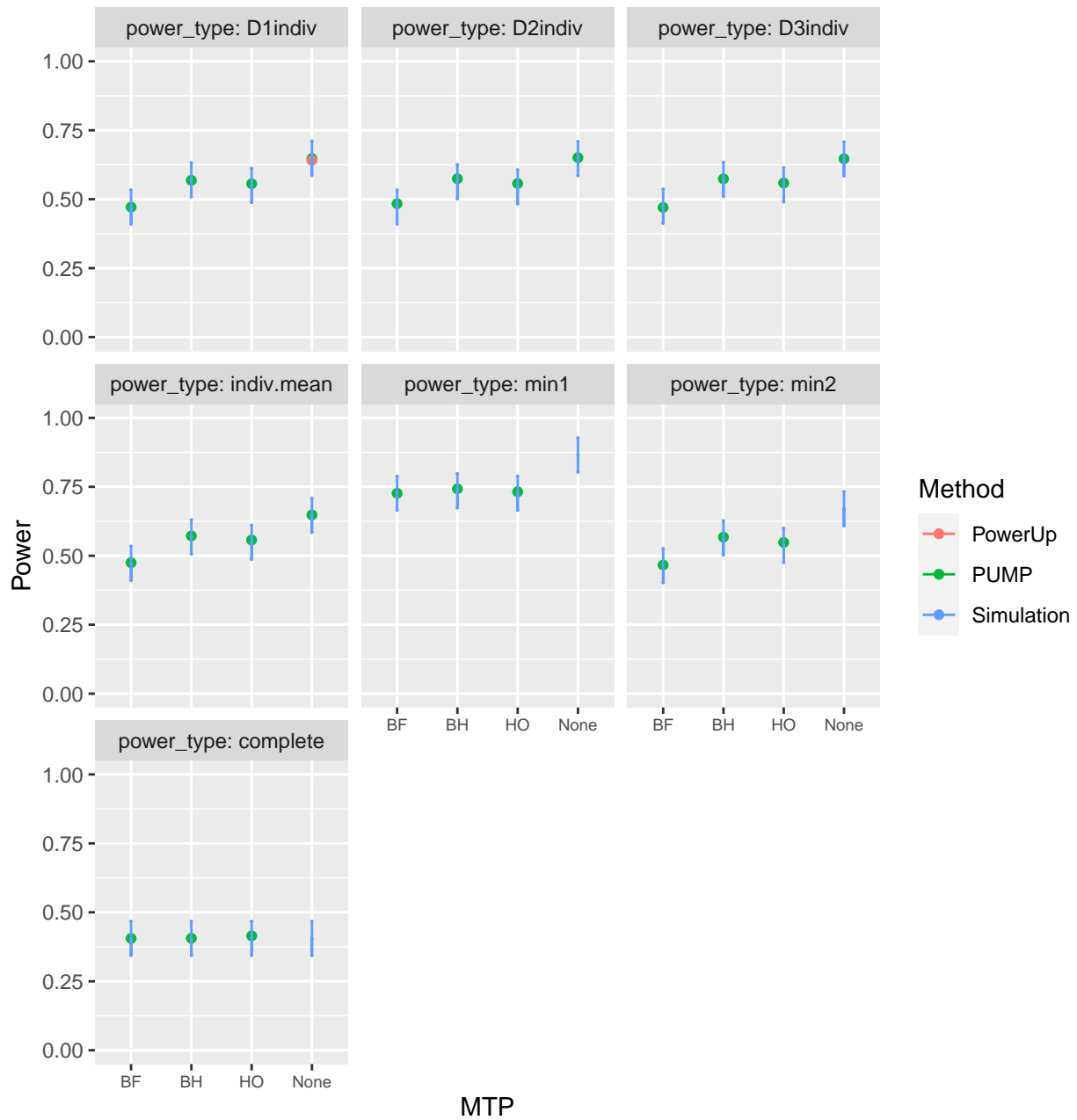


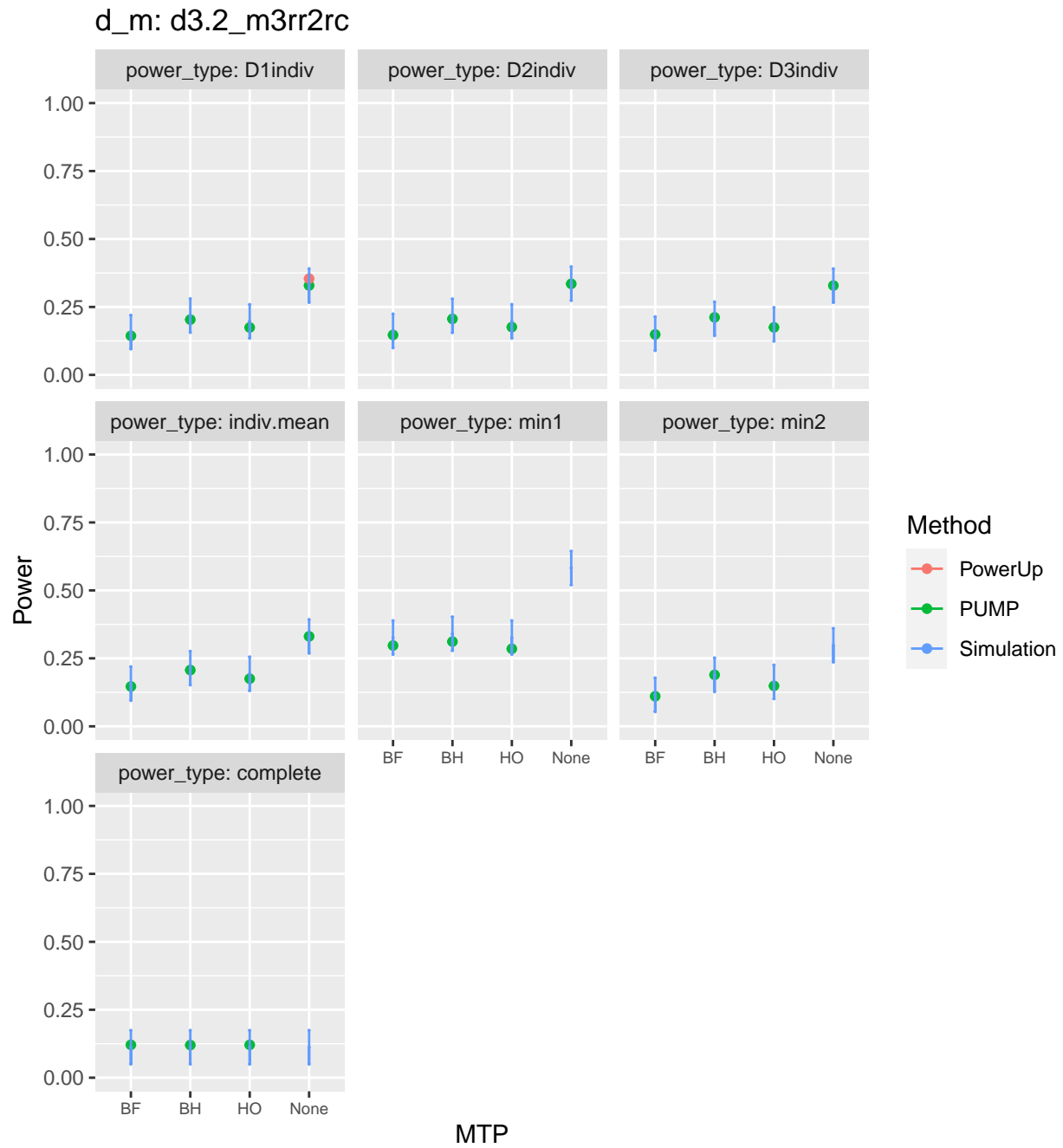




$$R_1^2 = 0, 0, 0 \quad R_2^2 = 0, 0, 0$$

d_m: d3.2_m3ff2rc

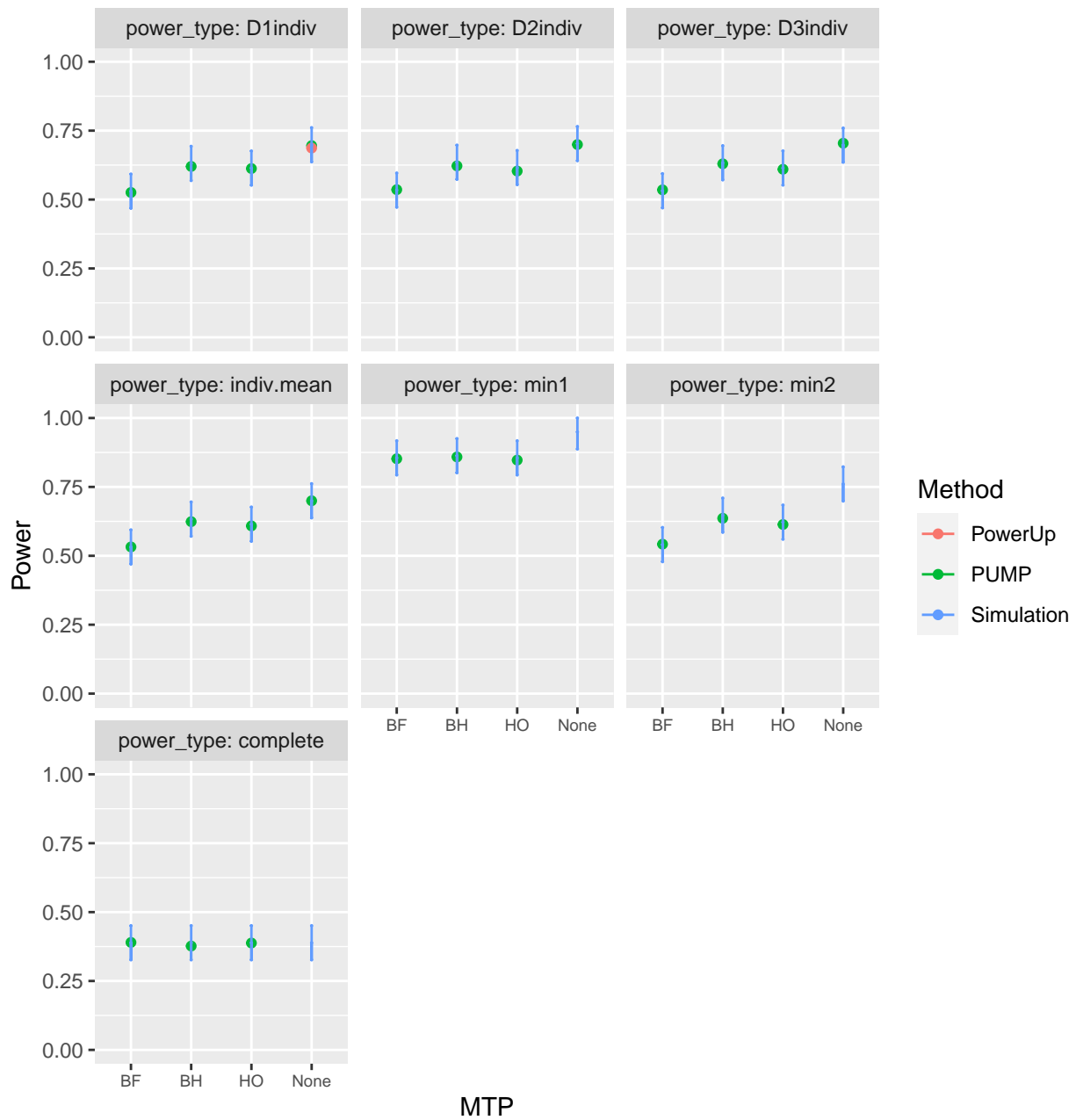




Varying rho

$\rho = 0.2$

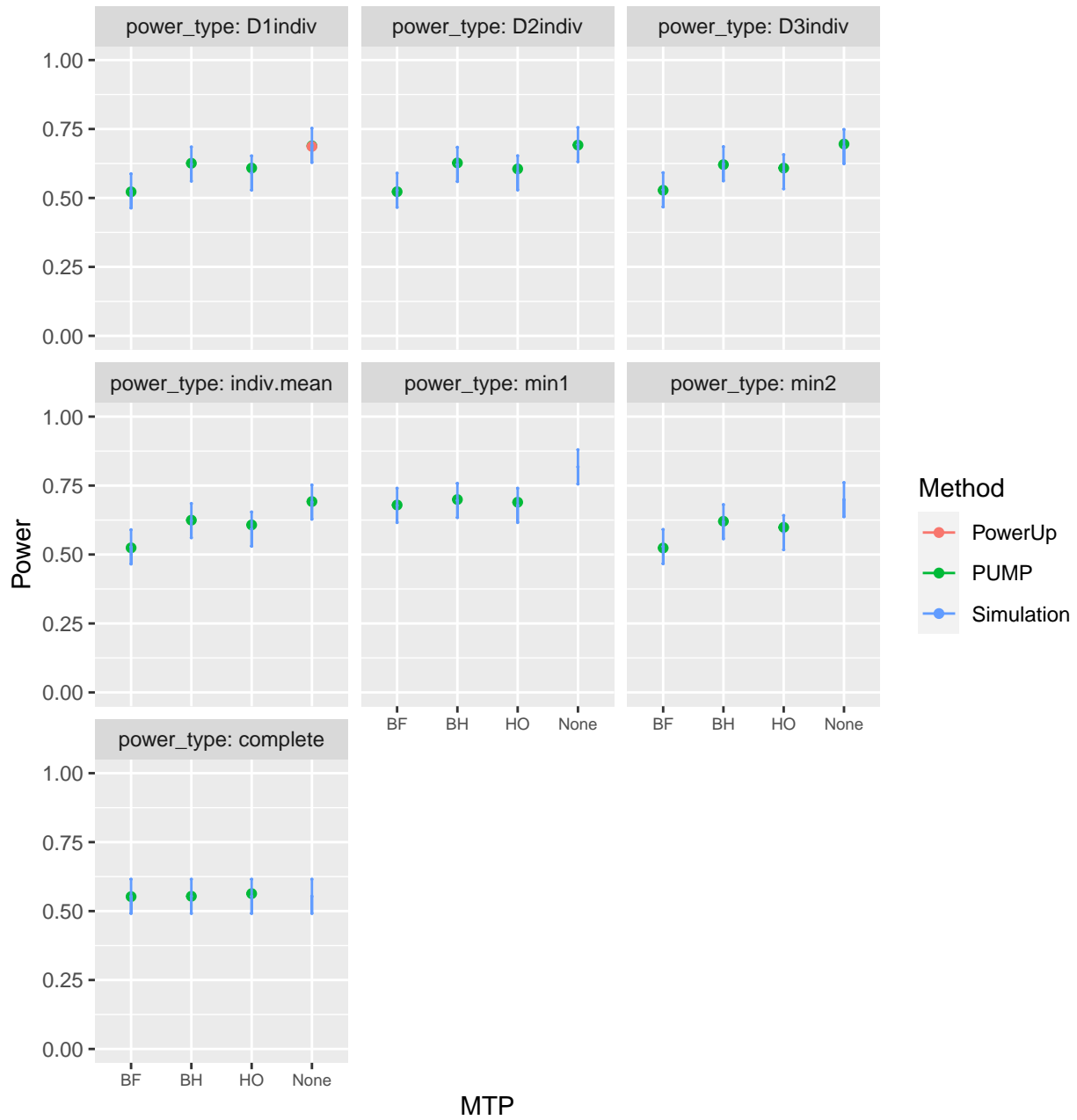
d_m: d3.2_m3ff2rc



MTP

$\rho = 0.8$

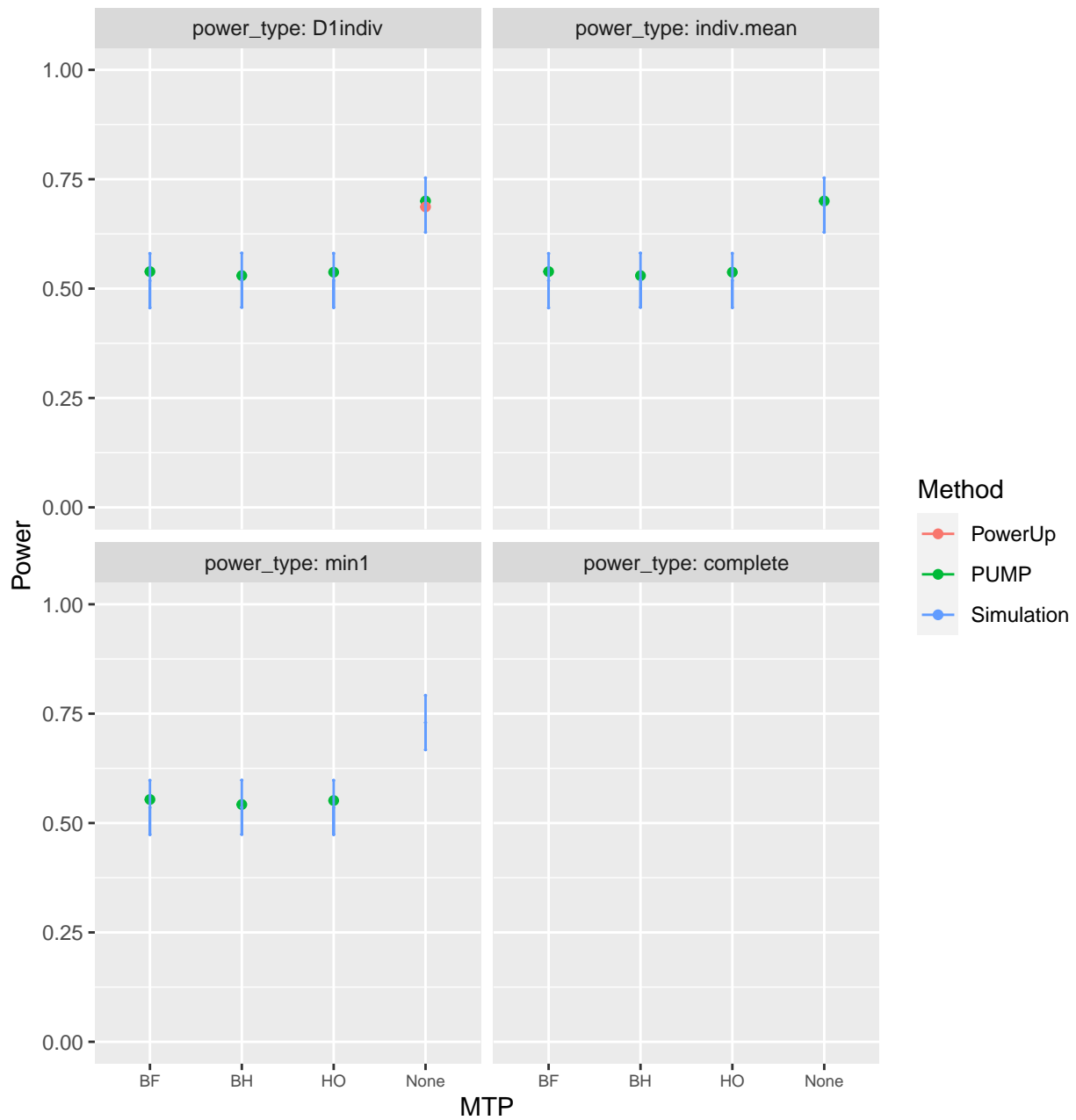
d_m: d3.2_m3ff2rc



Varying true positives

MDES = 0.125, 0, 0

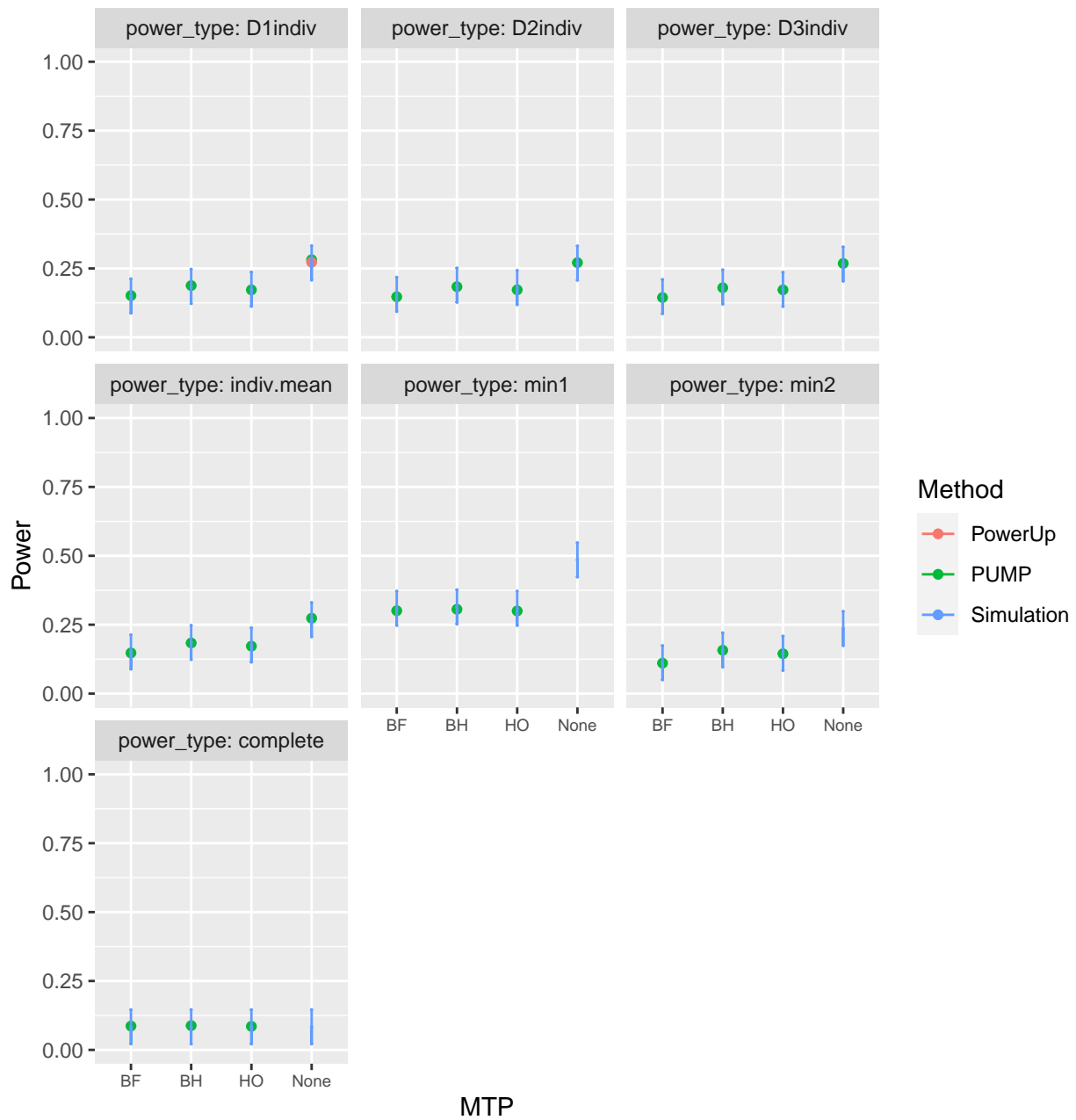
d_m: d3.2_m3ff2rc

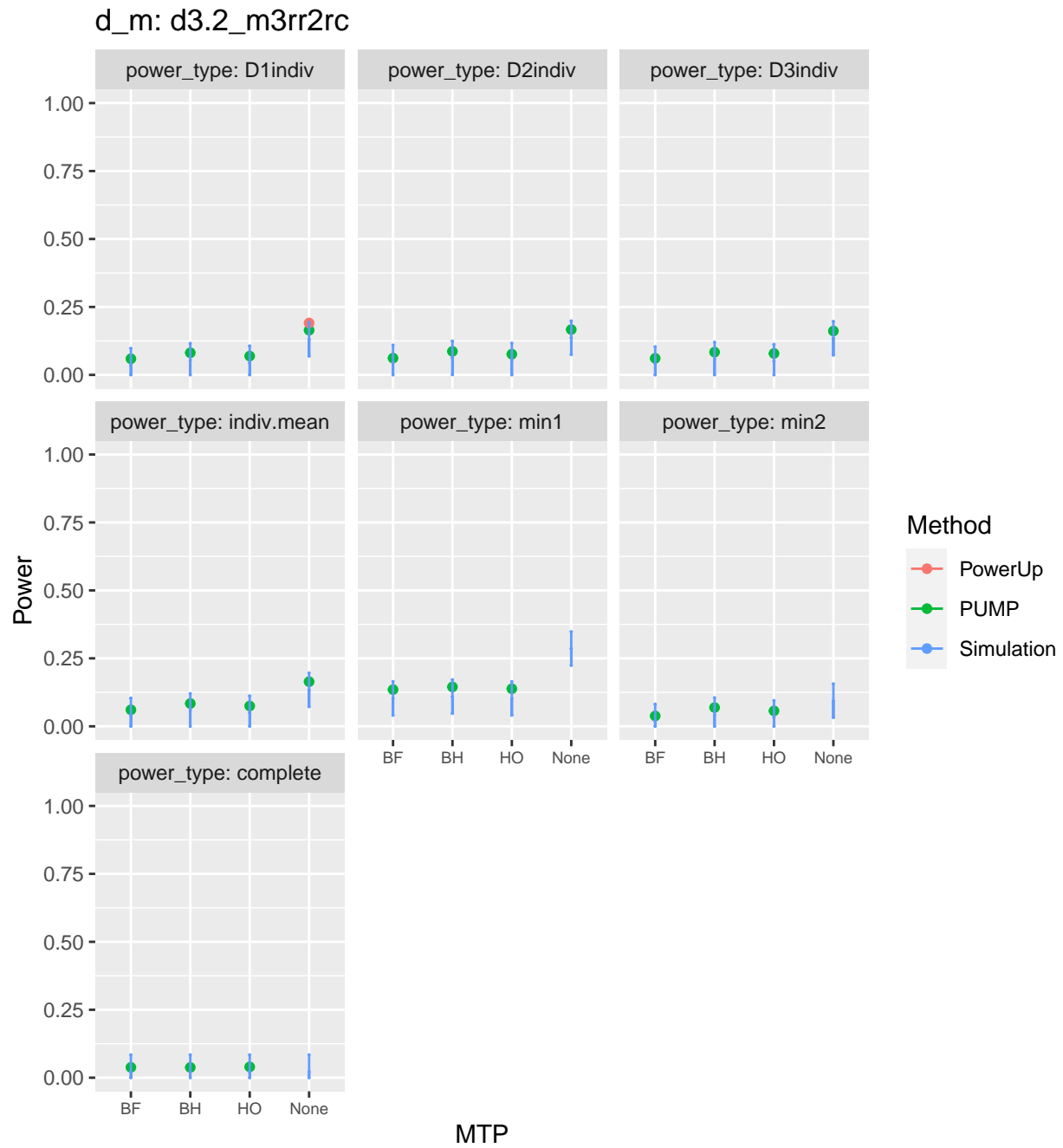


Varying ICC

$ICC_2 = 0.7, 0.7, 0.7$ $ICC_3 = 0.2, 0.2, 0.2$

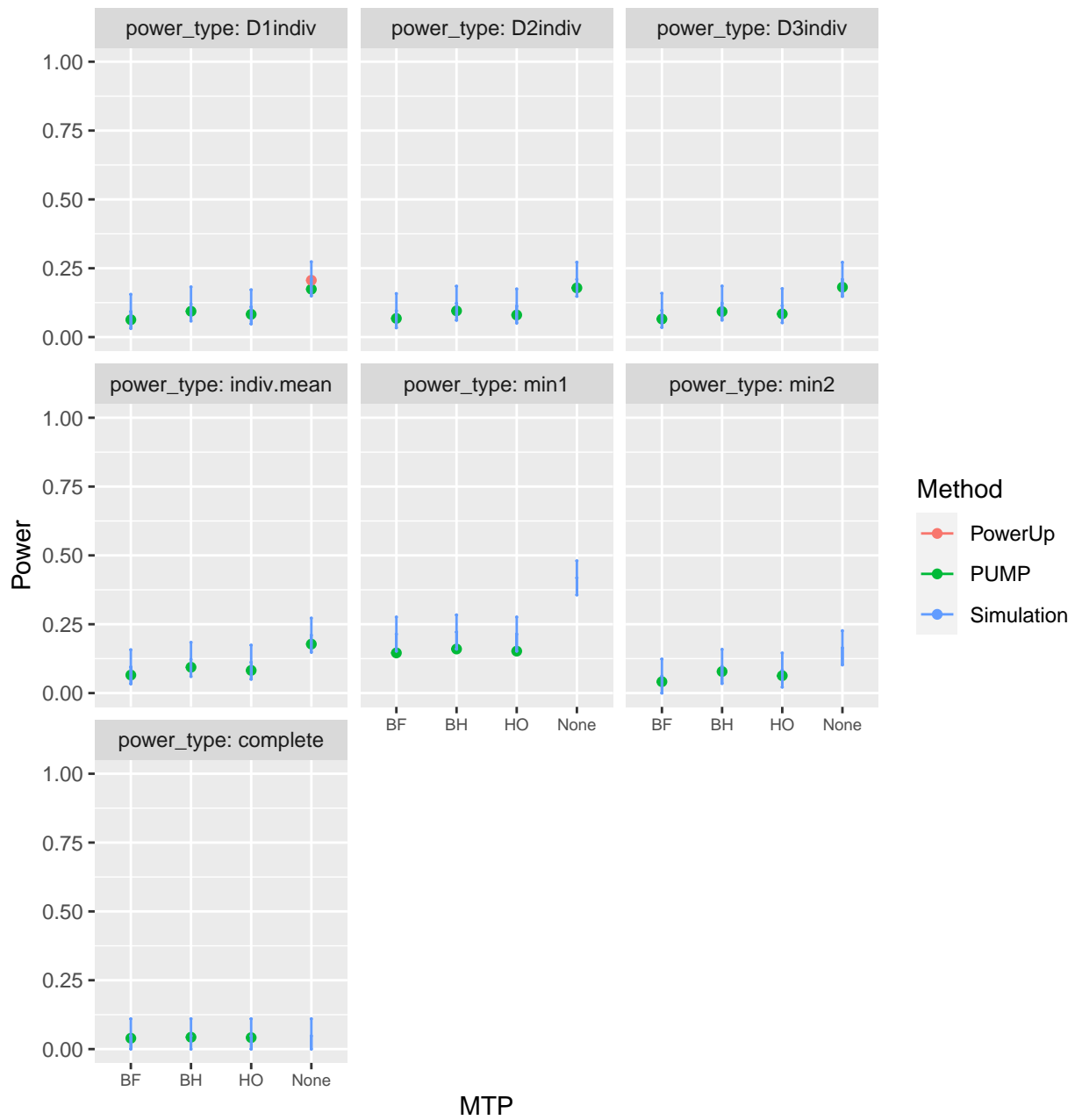
d_m: d3.2_m3ff2rc





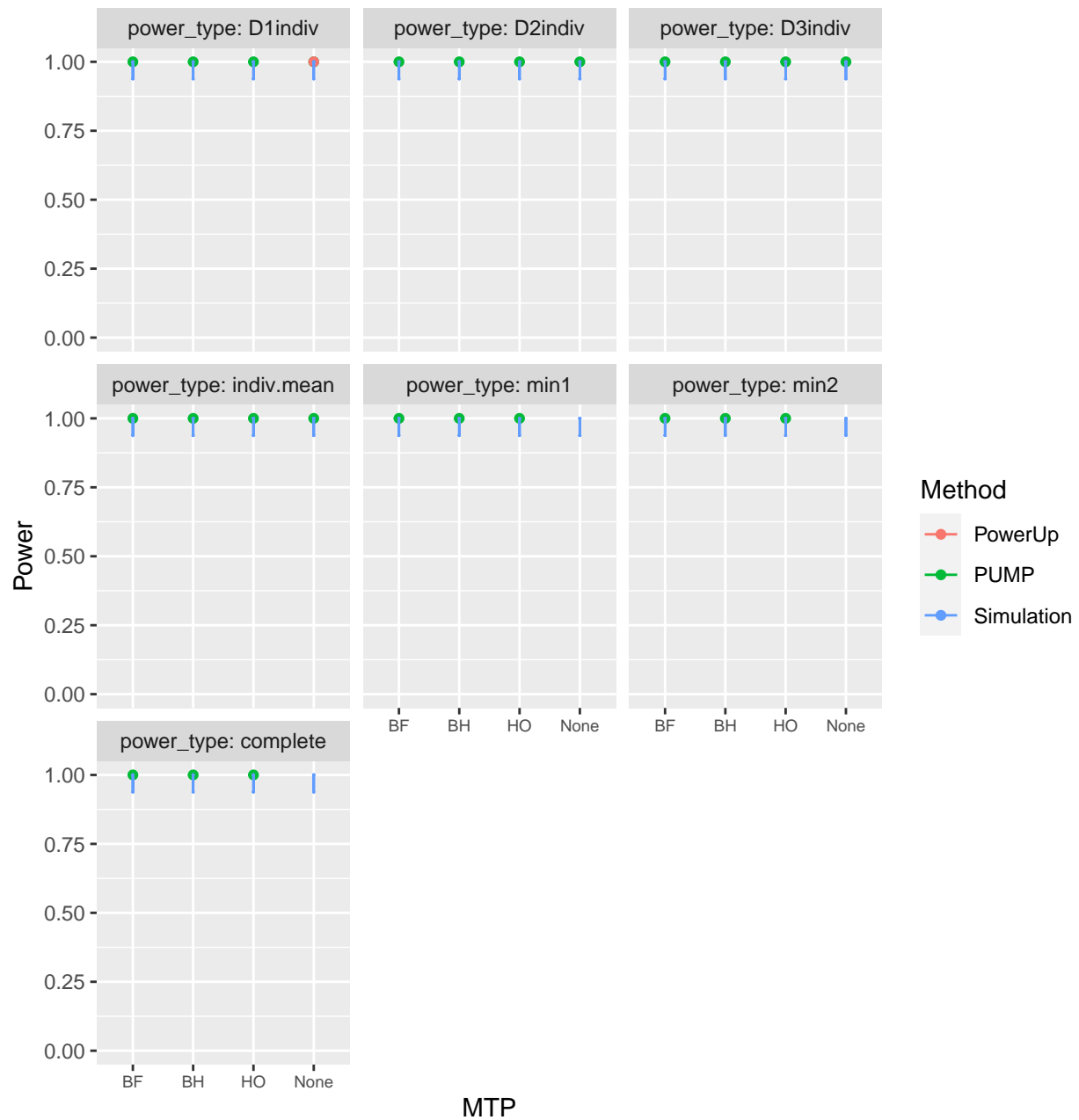
$ICC_2 = 0.2, 0.2, 0.2$ $ICC_3 = 0.7, 0.7, 0.7$

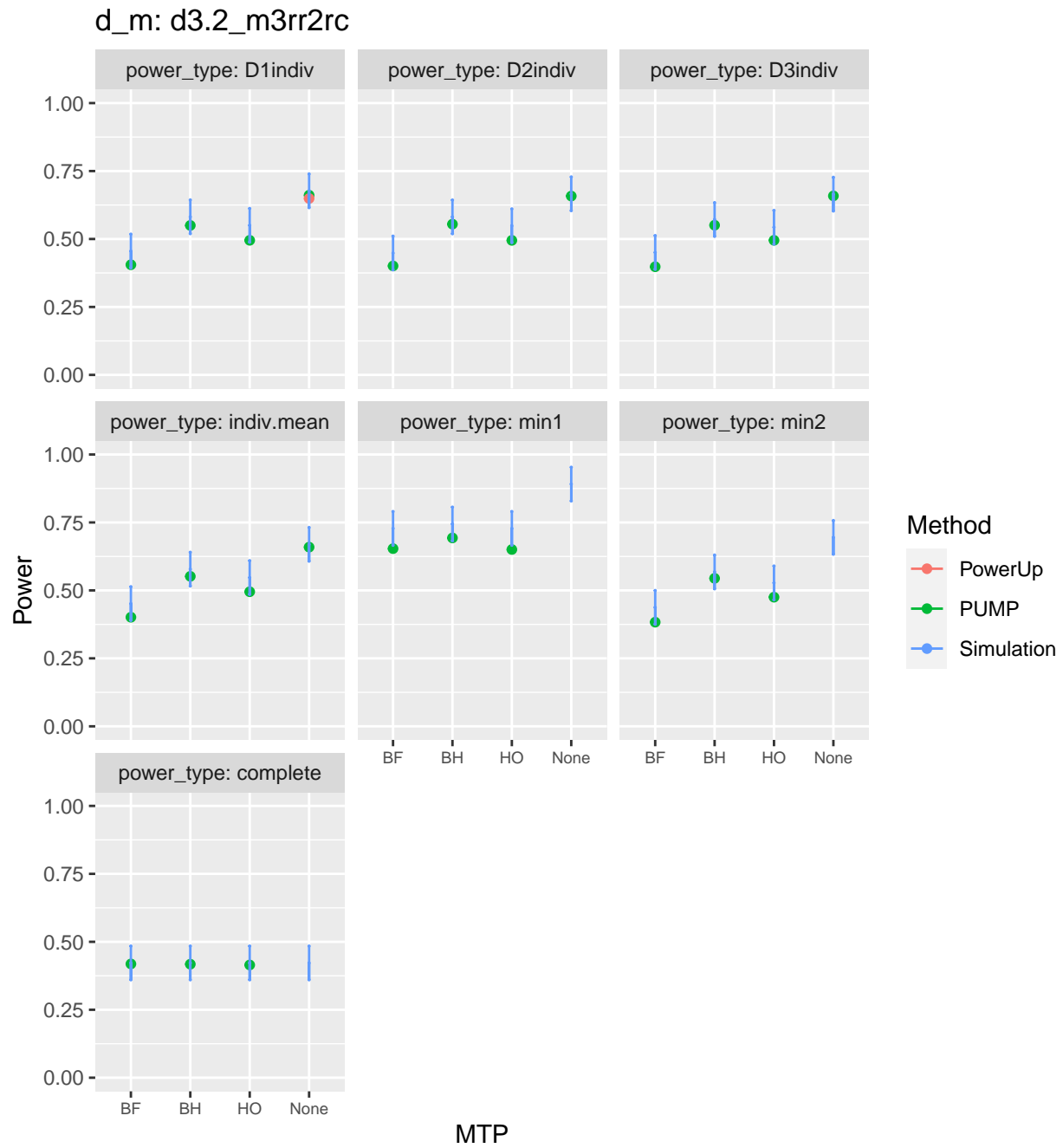
d_m: d3.2_m3rr2rc



$ICC_2 = 0, 0, 0$ $ICC_3 = 0.2, 0.2, 0.2$

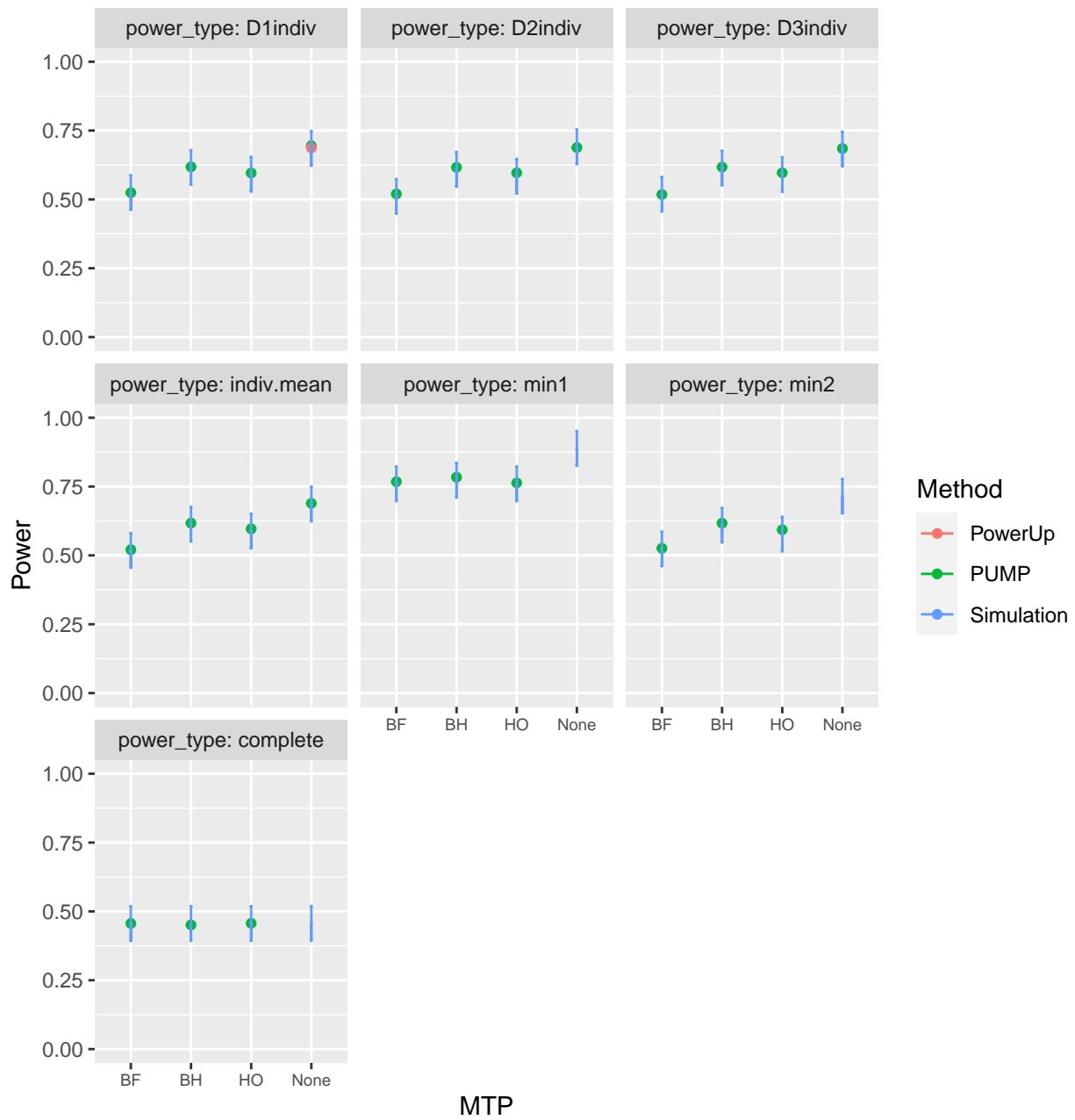
d_m: d3.2_m3ff2rc

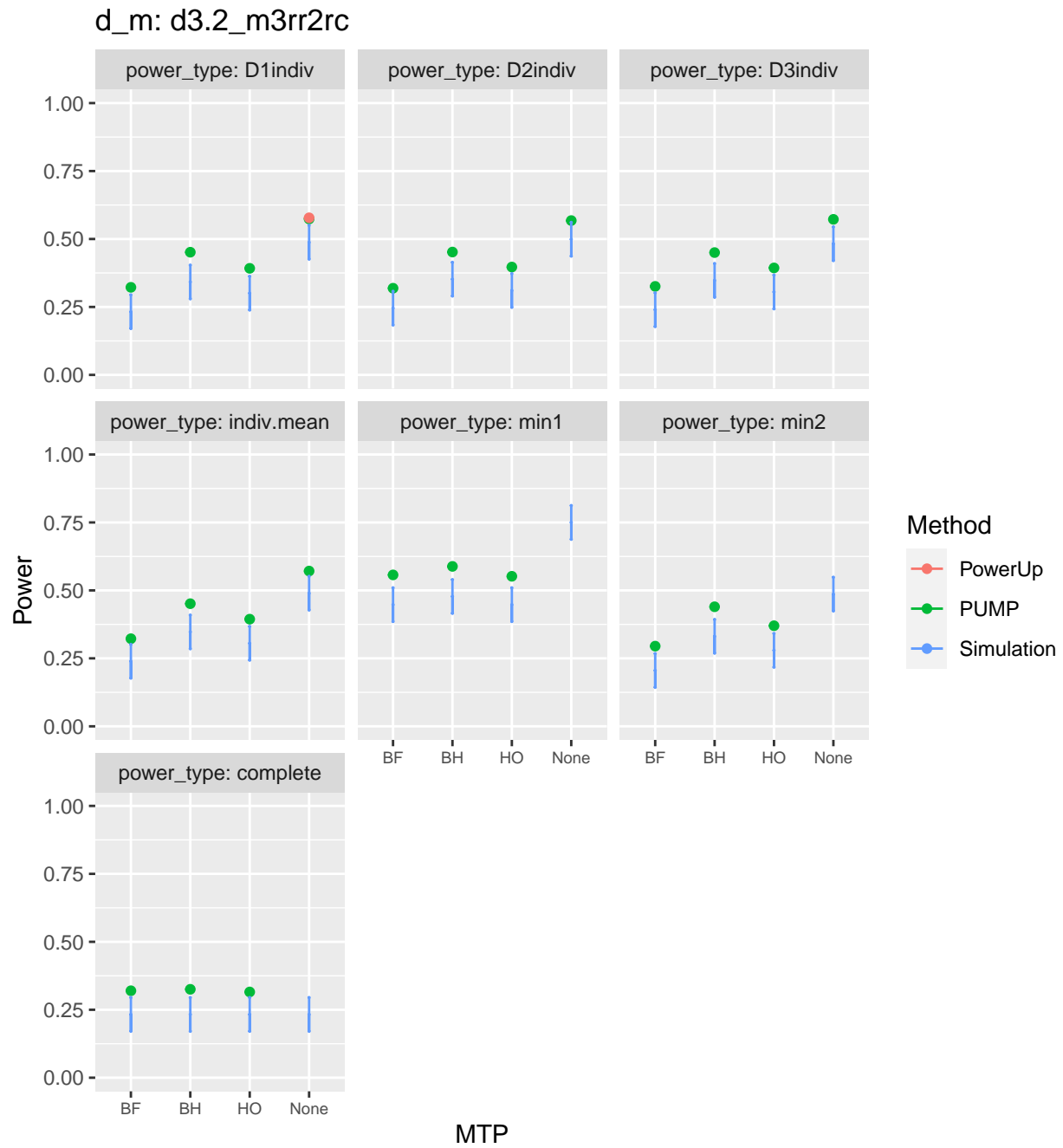




$ICC_2 = 0.2, 0.2, 0.2$ $ICC_3 = 0, 0, 0$

d_m: d3.2_m3ff2rc

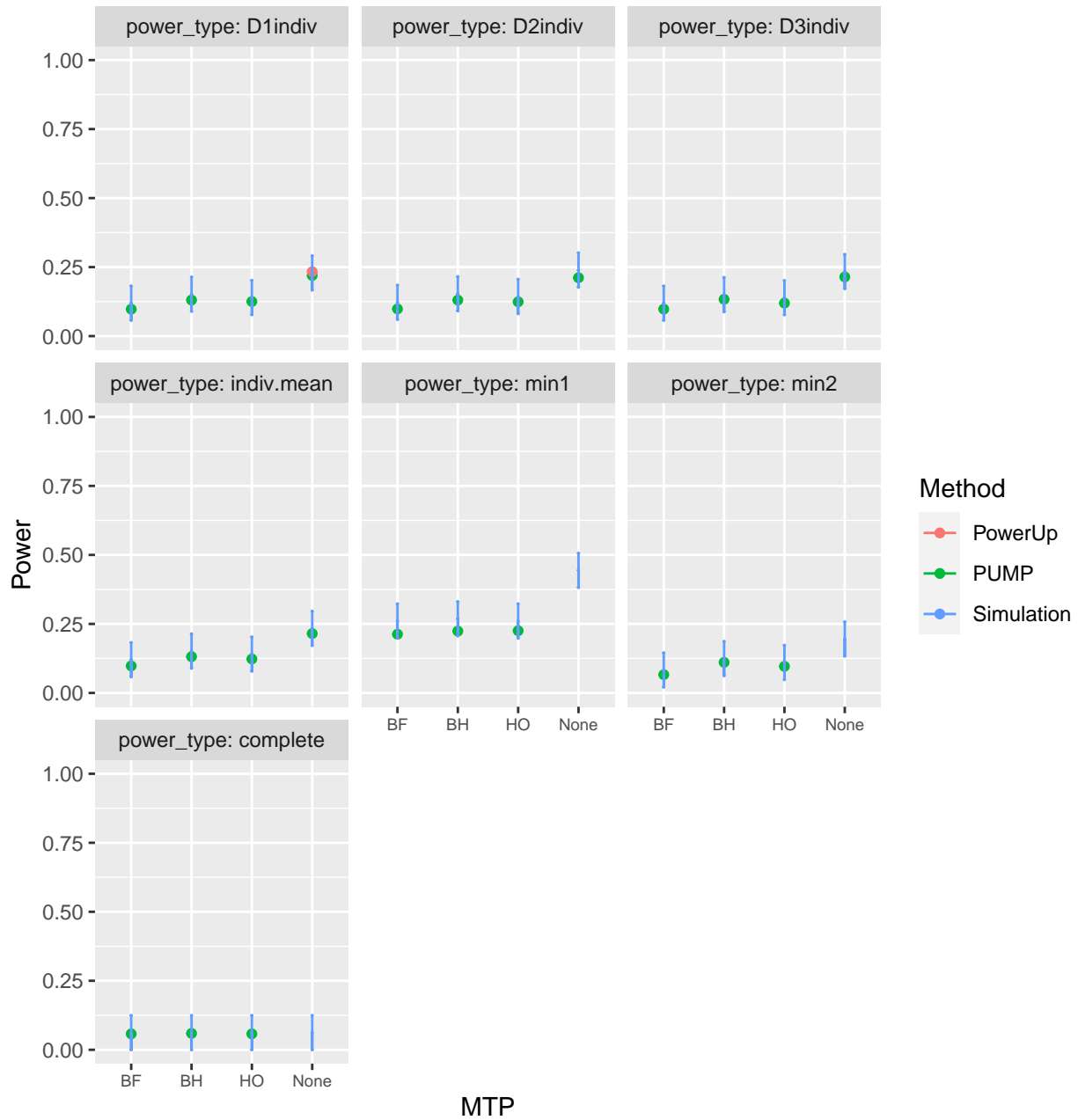




Varying Omega

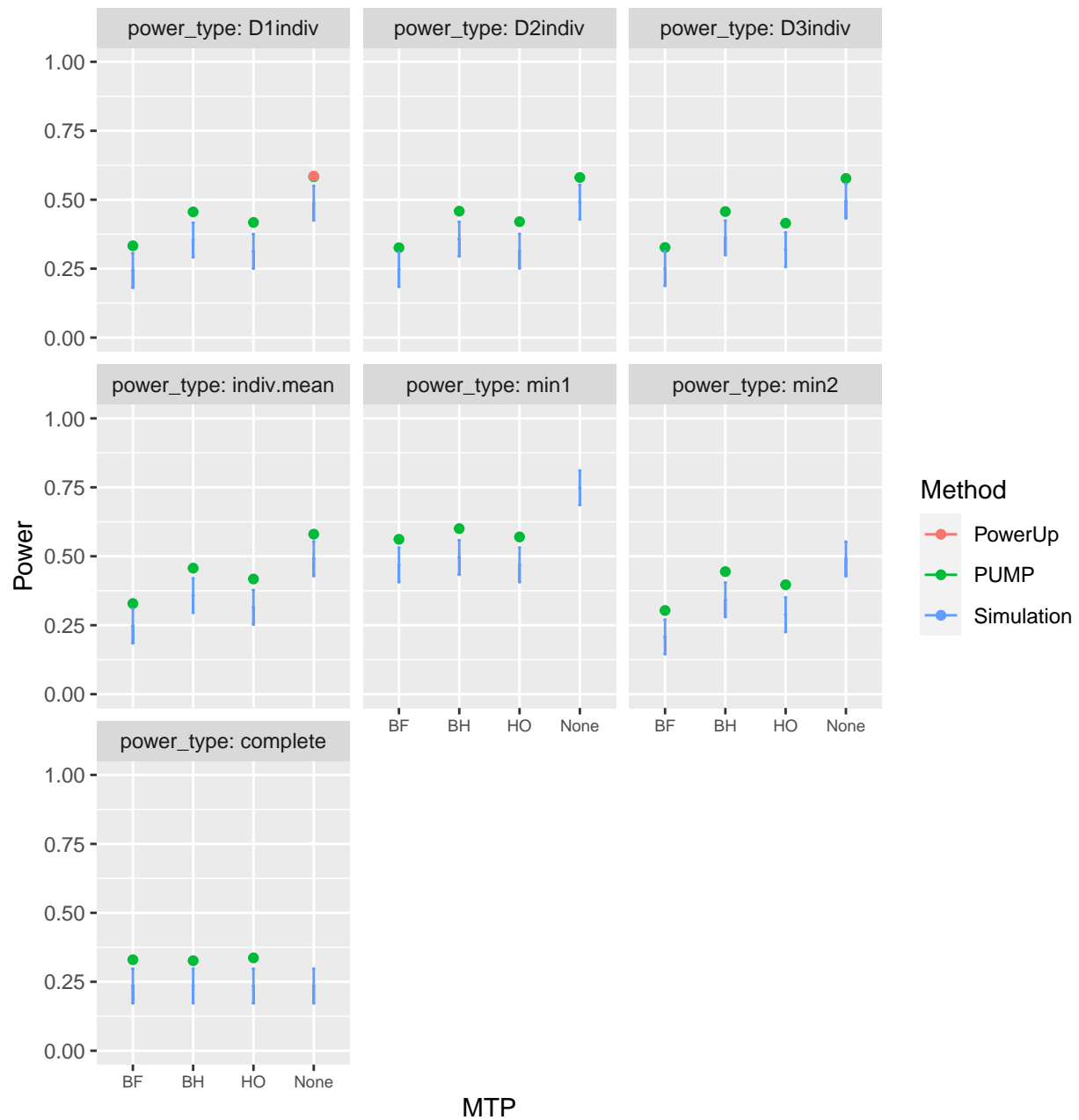
$\omega_3 = 0.8, 0.8, 0.8$

d_m: d3.2_m3rr2rc



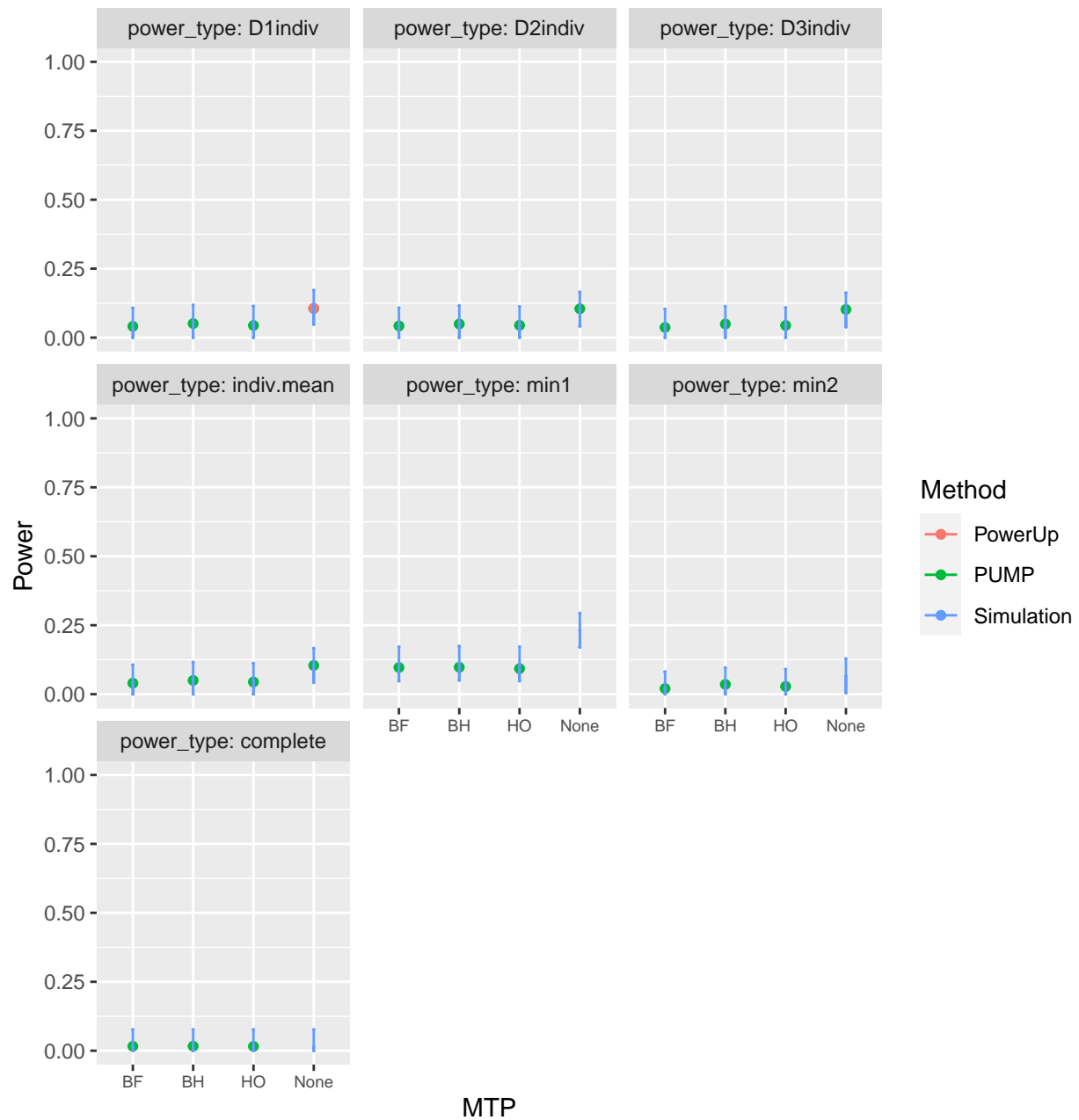
$\omega_3 = 0, 0, 0$ $ICC_3 = 0.2, 0.2, 0.2$

d_m: d3.2_m3rr2rc



$\omega_3 = 0.8, 0.8, 0.8$ $ICC_3 = 0.7, 0.7, 0.7$

d_m: d3.2_m3rr2rc



MDES validation

Target value: 0.125

```
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | MTP | Adjusted MDES | D1indiv Power | Target MDES | d_m | S | M | MDES |
## +=====+=====+=====+=====+=====+=====+=====+=====+=====+
## | BF | 0.124 | 0.522 | 0.125 | d3.2_m3ff2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | BH | 0.125 | 0.624 | 0.125 | d3.2_m3ff2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | HO | 0.126 | 0.61 | 0.125 | d3.2_m3ff2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
##
## Table: d3.2_m3ff2rc (continued below)
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | numZero | J | K | nbar | rho | omega.2 | omega.3 | R2.1 | R2.2 | R2.3 | ICC.2 | ICC.3 |
## +=====+=====+=====+=====+=====+=====+=====+=====+=====+
## | 0 | 30 | 10 | 50 | 0.5 | NA | NA | 0.1 | 0.1 | NA | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | 0 | 30 | 10 | 50 | 0.5 | NA | NA | 0.1 | 0.1 | NA | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | 0 | 30 | 10 | 50 | 0.5 | NA | NA | 0.1 | 0.1 | NA | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | MTP | Adjusted MDES | D1indiv Power | Target MDES | d_m | S | M | MDES |
## +=====+=====+=====+=====+=====+=====+=====+=====+=====+
## | BF | 0.125 | 0.155 | 0.125 | d3.2_m3rr2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | BH | 0.125 | 0.222 | 0.125 | d3.2_m3rr2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | HO | 0.127 | 0.199 | 0.125 | d3.2_m3rr2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
##
## Table: d3.2_m3rr2rc (continued below)
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | numZero | J | K | nbar | rho | omega.2 | omega.3 | R2.1 | R2.2 | R2.3 | ICC.2 | ICC.3 |
## +=====+=====+=====+=====+=====+=====+=====+=====+=====+
## | 0 | 30 | 10 | 50 | 0.5 | NA | 0.1 | 0.1 | 0.1 | NA | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | 0 | 30 | 10 | 50 | 0.5 | NA | 0.1 | 0.1 | 0.1 | NA | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | 0 | 30 | 10 | 50 | 0.5 | NA | 0.1 | 0.1 | 0.1 | NA | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

Sample size validation

Target value: 10

```
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+
## | MTP | Sample.type | Sample.size | D1indiv.power | d_m | S | M | MDES |
## +=====+=====+=====+=====+=====+=====+=====+=====+
## | BF | K | 10 | 0.522 | d3.2_m3ff2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+
## | BH | K | 11 | 0.638 | d3.2_m3ff2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+
## | HO | K | 10 | 0.6 | d3.2_m3ff2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+
```

```
##
## Table: d3.2_m3ff2rc (continued below)
##
##
```

```
## +-----+-----+-----+-----+-----+-----+-----+-----+
## | numZero | J | K | nbar | rho | omega.2 | omega.3 | R2.1 | R2.2 | R2.3 | ICC.2 | ICC.3 |
## +=====+=====+=====+=====+=====+=====+=====+=====+
## | 0 | 30 | NA | 50 | 0.5 | NA | NA | 0.1 | 0.1 | NA | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+
## | 0 | 30 | NA | 50 | 0.5 | NA | NA | 0.1 | 0.1 | NA | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+
## | 0 | 30 | NA | 50 | 0.5 | NA | NA | 0.1 | 0.1 | NA | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+
```

Target value: 30

```
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+
## | MTP | Sample.type | Sample.size | D1indiv.power | d_m | S | M | MDES |
## +=====+=====+=====+=====+=====+=====+=====+=====+
## | BF | J | 30 | 0.522 | d3.2_m3ff2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+
## | BH | J | 31 | 0.631 | d3.2_m3ff2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+
## | HO | J | 31 | 0.61 | d3.2_m3ff2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+
```

```
##
## Table: d3.2_m3ff2rc (continued below)
##
##
```

```
## +-----+-----+-----+-----+-----+-----+-----+-----+
## | numZero | J | K | nbar | rho | omega.2 | omega.3 | R2.1 | R2.2 | R2.3 | ICC.2 | ICC.3 |
## +=====+=====+=====+=====+=====+=====+=====+=====+
## | 0 | NA | 10 | 50 | 0.5 | NA | NA | 0.1 | 0.1 | NA | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+
## | 0 | NA | 10 | 50 | 0.5 | NA | NA | 0.1 | 0.1 | NA | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+
```

```
## |    0    | NA | 10 | 50 | 0.5 |  NA   |   NA   | 0.1 | 0.1 |  NA   | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

Target value: 50

```
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | MTP | Sample.type | Sample.size | D1indiv.power |      d_m      | S | M | MDES |
## +=====+=====+=====+=====+=====+=====+=====+=====+=====+
## | BF  |      nbar    |      41.22   |      0.522    | d3.2_m3ff2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | BH  |      nbar    |      99      |      0.64     | d3.2_m3ff2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | HO  |      nbar    |      71      |      0.613    | d3.2_m3ff2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

Table: d3.2_m3ff2rc (continued below)

```
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | numZero | J | K | rho | omega.2 | omega.3 | R2.1 | R2.2 | R2.3 | ICC.2 | ICC.3 |
## +=====+=====+=====+=====+=====+=====+=====+=====+=====+
## |    0    | 30 | 10 | 0.5 |  NA     |  NA     | 0.1  | 0.1  |  NA   | 0.2   | 0.2   |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## |    0    | 30 | 10 | 0.5 |  NA     |  NA     | 0.1  | 0.1  |  NA   | 0.2   | 0.2   |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## |    0    | 30 | 10 | 0.5 |  NA     |  NA     | 0.1  | 0.1  |  NA   | 0.2   | 0.2   |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

Target value: 10

```
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | MTP | Sample.type | Sample.size | D1indiv.power |      d_m      | S | M | MDES |
## +=====+=====+=====+=====+=====+=====+=====+=====+=====+
## | BF  |      K      |      10     |      0.155    | d3.2_m3rr2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | BH  |      K      |      11     |      0.233    | d3.2_m3rr2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | HO  |      K      |      11     |      0.194    | d3.2_m3rr2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

Table: d3.2_m3rr2rc (continued below)

```
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | numZero | J | K | nbar | rho | omega.2 | omega.3 | R2.1 | R2.2 | R2.3 | ICC.2 | ICC.3 |
## +=====+=====+=====+=====+=====+=====+=====+=====+=====+
## |    0    | 30 | NA | 50 | 0.5 |  NA     |  0.1   | 0.1  | 0.1  |  NA   | 0.2   | 0.2   |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## |    0    | 30 | NA | 50 | 0.5 |  NA     |  0.1   | 0.1  | 0.1  |  NA   | 0.2   | 0.2   |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

```
## |    0    | 30 | NA | 50 | 0.5 |  NA   |    0.1   | 0.1 | 0.1 |  NA   | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

Target value: 30

```
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | MTP | Sample.type | Sample.size | D1indiv.power |      d_m      | S | M | MDES |
## +=====+=====+=====+=====+=====+=====+=====+=====+=====+
## | BF  |      J      |      30     |      0.155    | d3.2_m3rr2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | BH  |      J      |      32     |      0.23     | d3.2_m3rr2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | HO  |      J      |      32     |      0.2      | d3.2_m3rr2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

Table: d3.2_m3rr2rc (continued below)

```
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | numZero | J | K | nbar | rho | omega.2 | omega.3 | R2.1 | R2.2 | R2.3 | ICC.2 | ICC.3 |
## +=====+=====+=====+=====+=====+=====+=====+=====+=====+
## |    0    | NA | 10 | 50 | 0.5 |  NA   |    0.1   | 0.1 | 0.1 |  NA   | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## |    0    | NA | 10 | 50 | 0.5 |  NA   |    0.1   | 0.1 | 0.1 |  NA   | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## |    0    | NA | 10 | 50 | 0.5 |  NA   |    0.1   | 0.1 | 0.1 |  NA   | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

Target value: 50

```
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | MTP | Sample.type | Sample.size | D1indiv.power |      d_m      | S | M | MDES |
## +=====+=====+=====+=====+=====+=====+=====+=====+=====+
## | BF  |      nbar   |      58.08  |      0.155    | d3.2_m3rr2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | BH  |      nbar   |     22500   |      0.232    | d3.2_m3rr2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | HO  |      nbar   |      691    |      0.202    | d3.2_m3rr2rc | 5000 | 3 | 0.125 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

Table: d3.2_m3rr2rc (continued below)

```
##
##
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## | numZero | J | K | rho | omega.2 | omega.3 | R2.1 | R2.2 | R2.3 | ICC.2 | ICC.3 |
## +=====+=====+=====+=====+=====+=====+=====+=====+=====+
## |    0    | 30 | 10 | 0.5 |  NA   |    0.1   | 0.1 | 0.1 |  NA   | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
## |    0    | 30 | 10 | 0.5 |  NA   |    0.1   | 0.1 | 0.1 |  NA   | 0.2 | 0.2 |
## +-----+-----+-----+-----+-----+-----+-----+-----+-----+
```