Validate Power: d3.2

February 25, 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: $\text{ICC}_2 = 0.2, 0.2, 0.2$, $\text{ICC}_3 = 0.2, 0.2, 0.2$
- Omega2: $\omega_2 = 0$

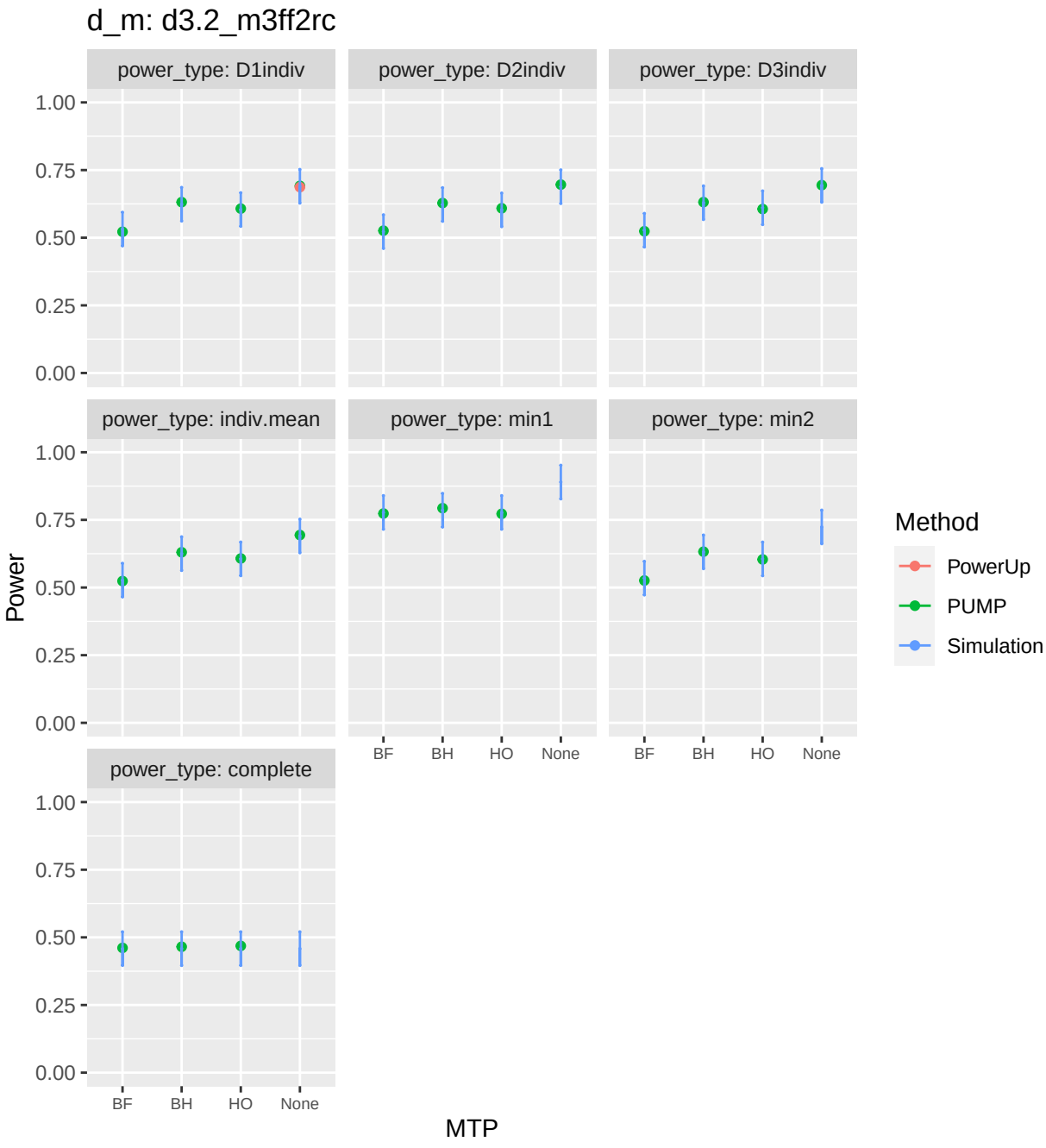
Parameters by model type:

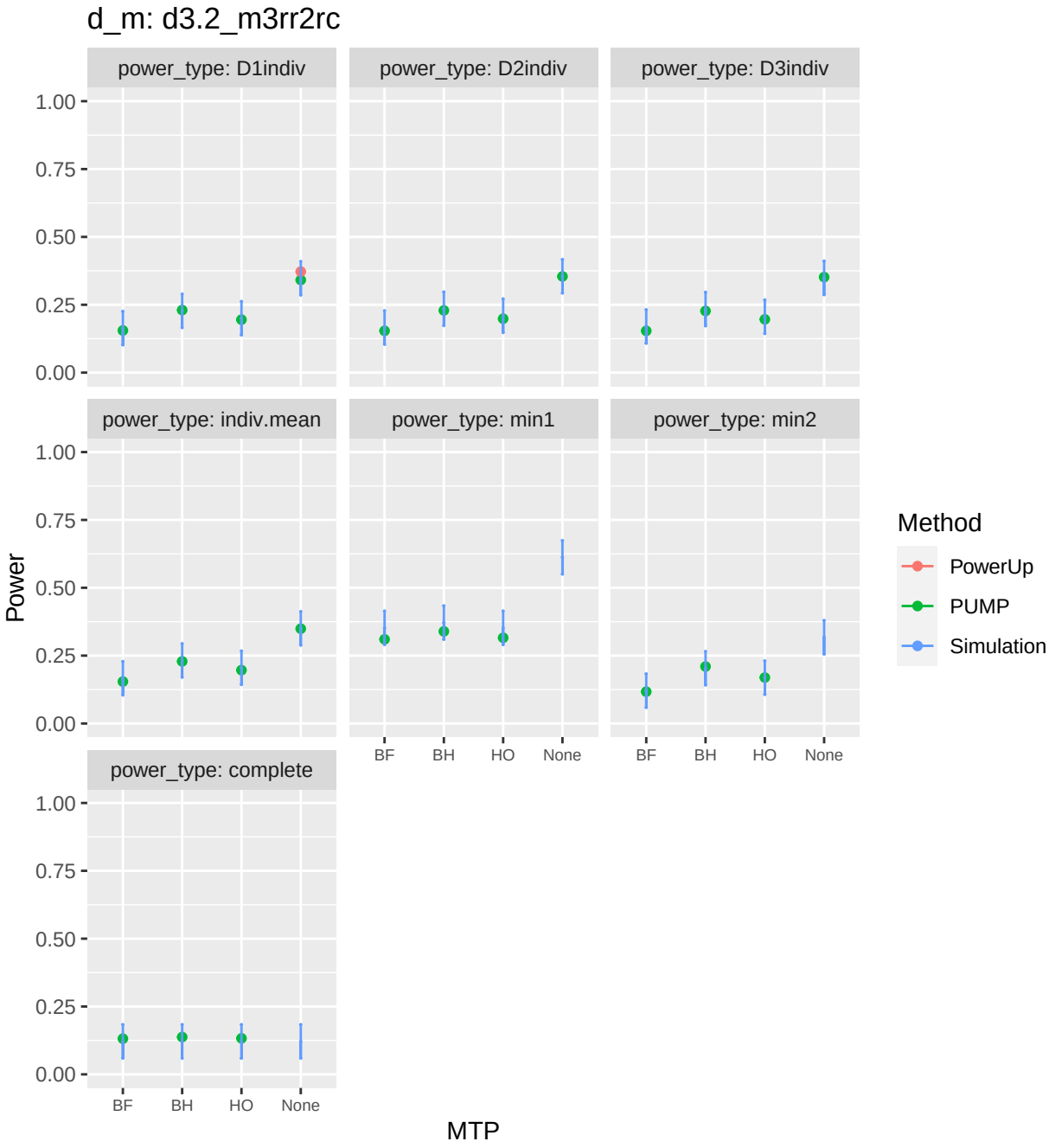
- Omega3: $\omega_3 = 0$ for fixed effects, $\text{omega}_3 = 0.1, 0.1, 0.1$ for random effects

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

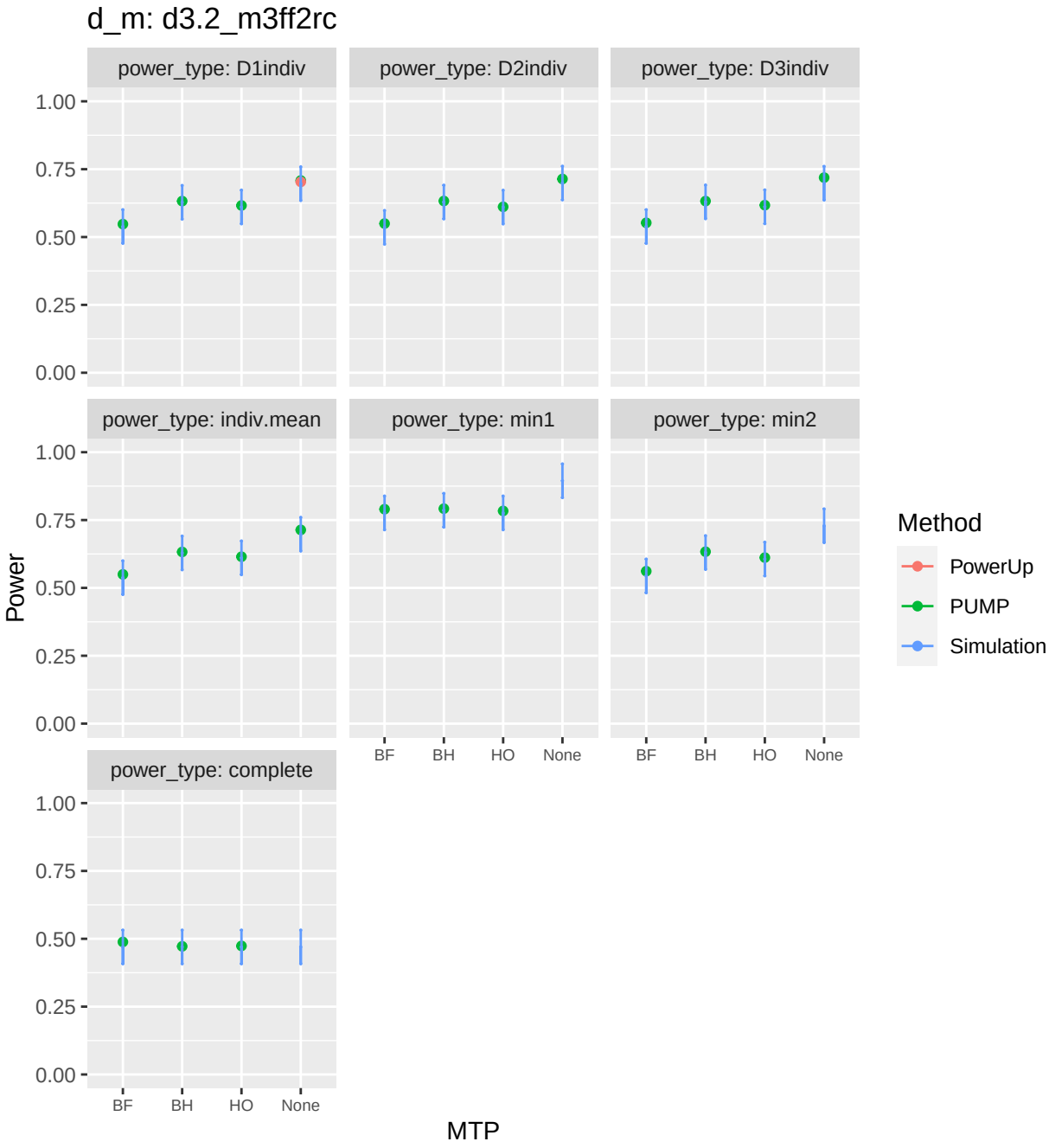
Base case

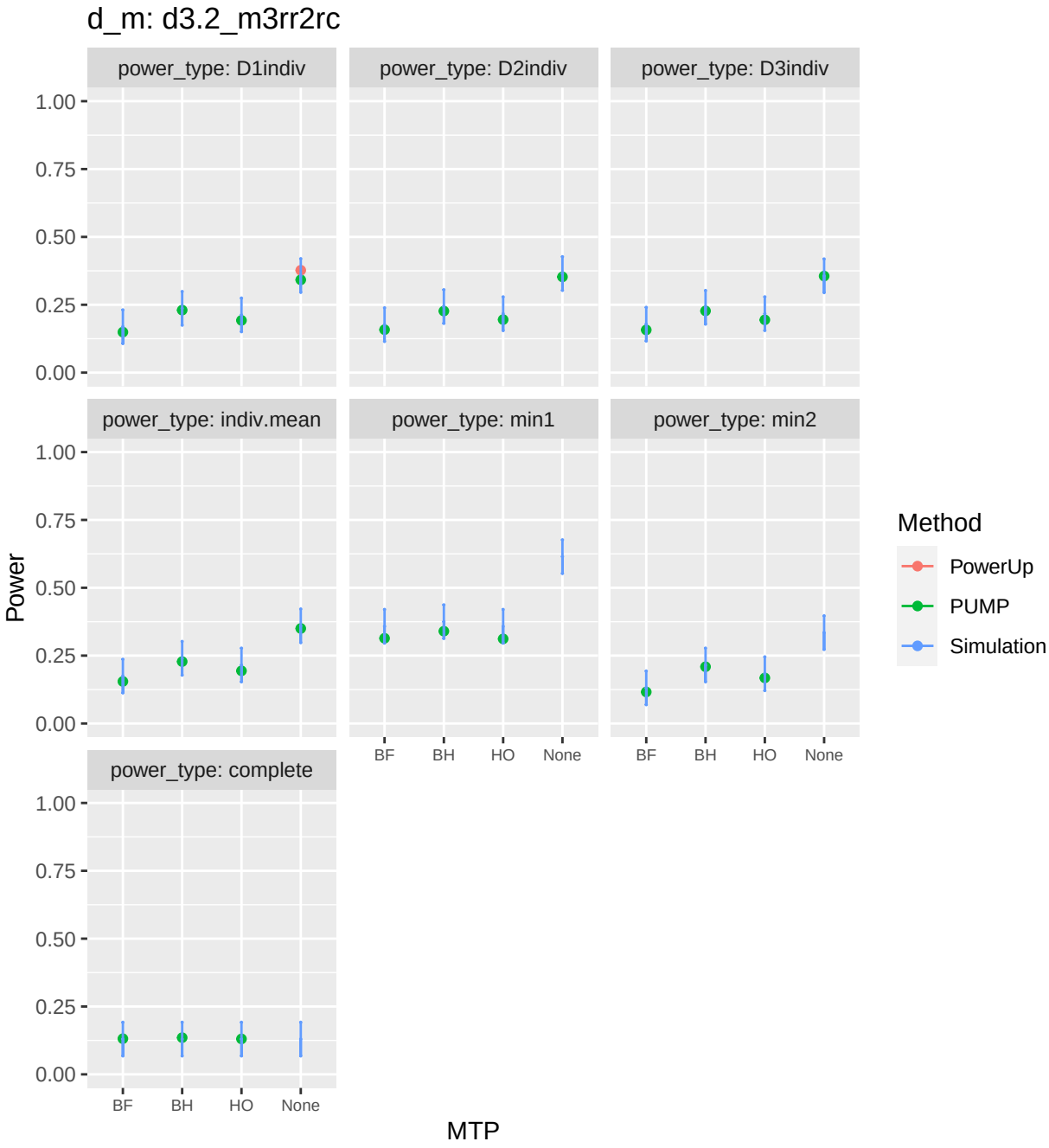



d_m: d3.2_m3rr2rc
power_type: D1indiv
power_type: D2indiv
power_type: D3indiv
power_type: indiv.mean
power_type: min1
power_type: min2
power_type: complete
Power
1.00
0.75
0.50
0.25
0.00
BF
BH
HO
None
MTP
Method
PowerUp
PUMP
Simulation

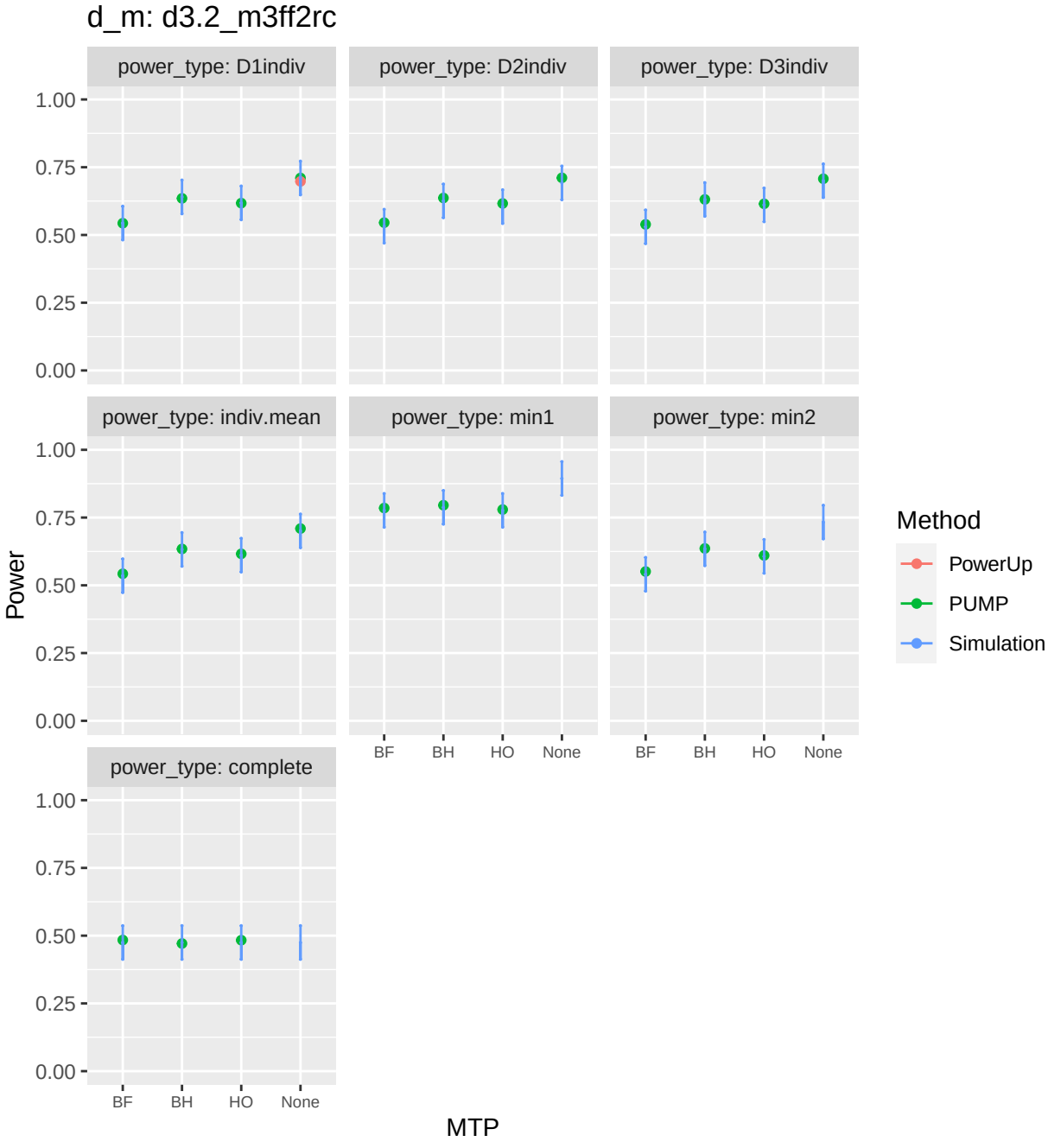
Varying school size

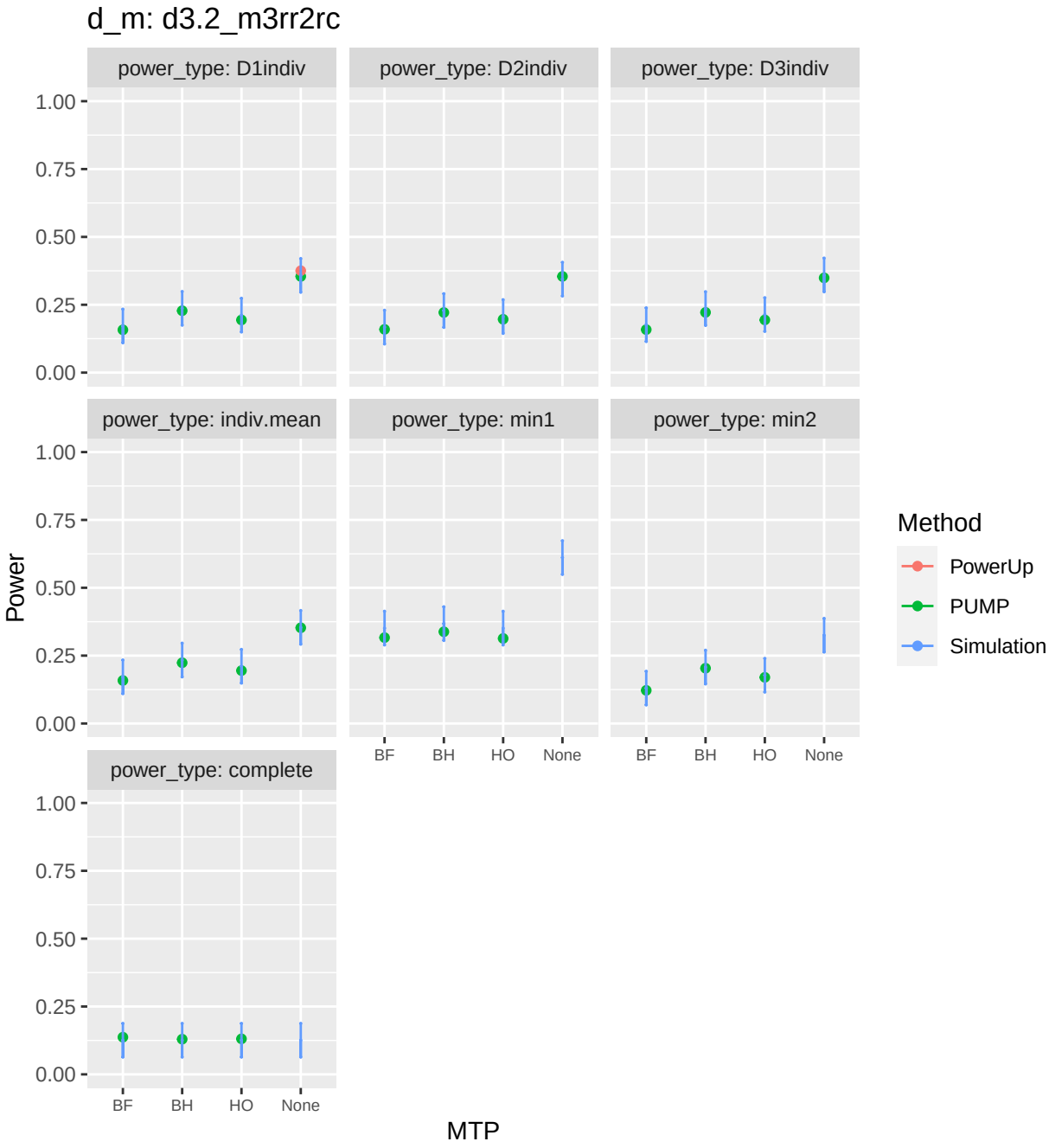
$\bar{n} = 100$




d_m: d3.2_m3rr2rc
power_type: D1indiv
power_type: D2indiv
power_type: D3indiv
power_type: indiv.mean
power_type: min1
power_type: min2
power_type: complete
Power
1.00
0.75
0.50
0.25
0.00
BF
BH
HO
None
MTP
Method
PowerUp
PUMP
Simulation

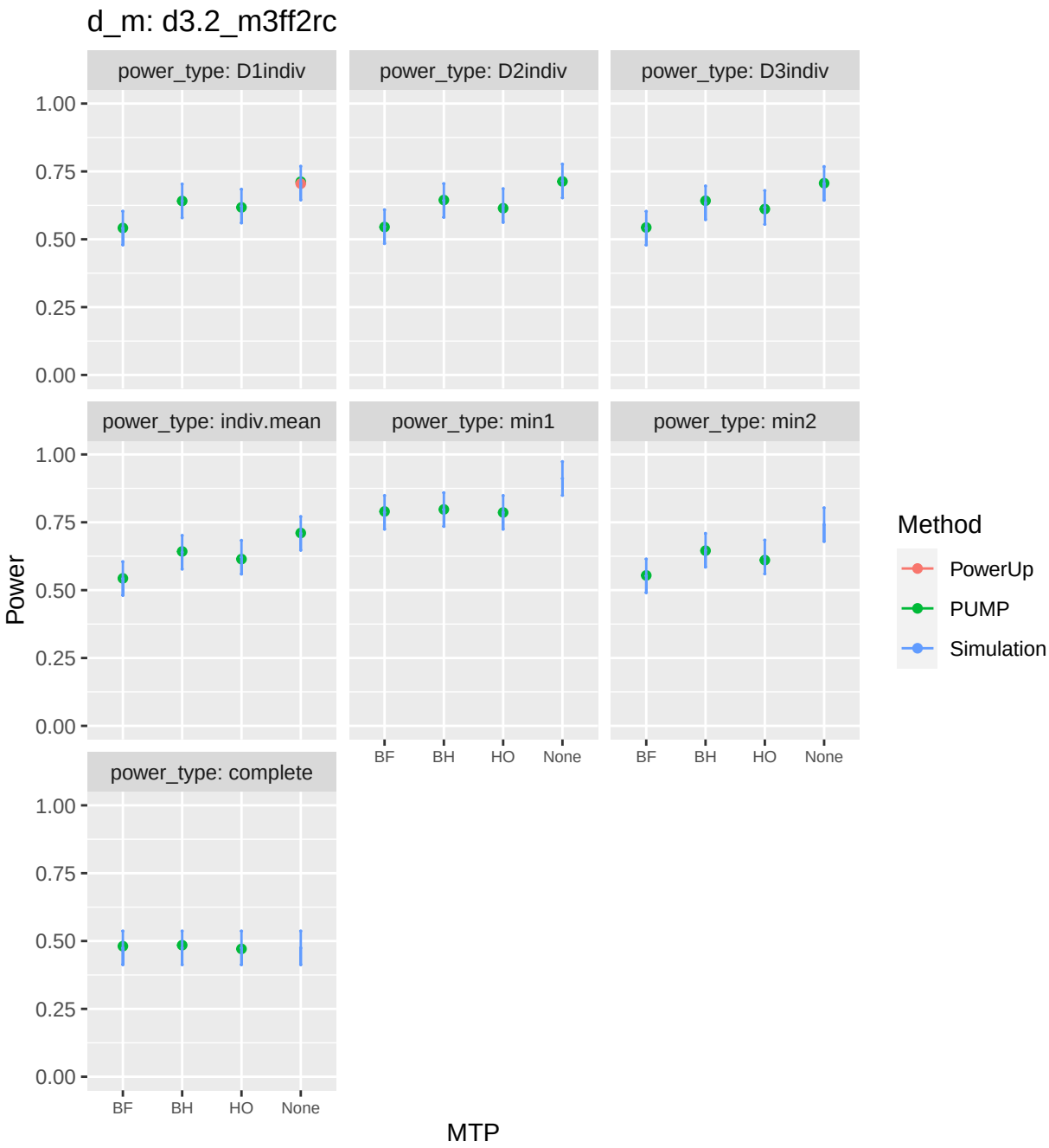
$\bar{n} = 75$

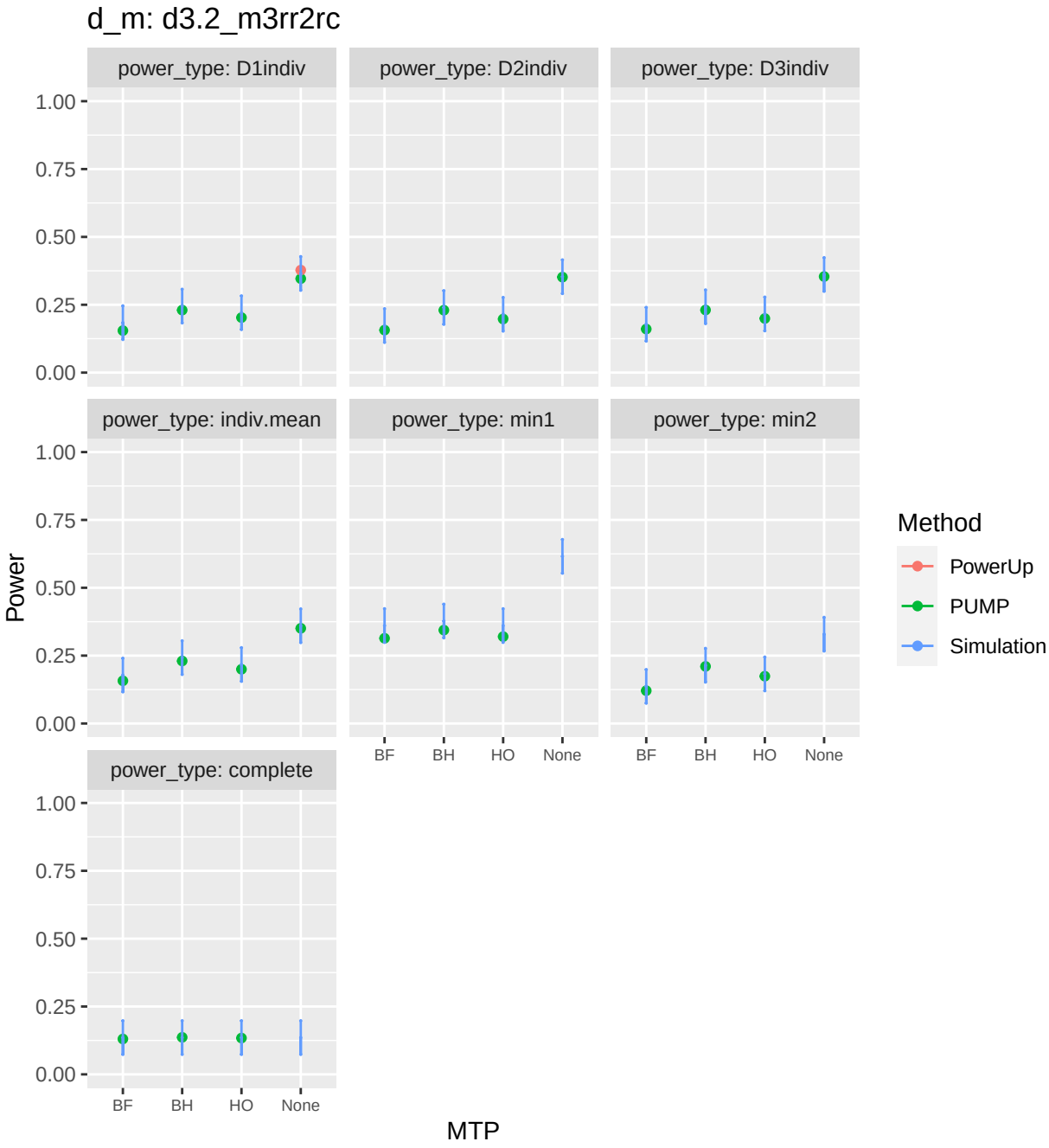

d_m: d3.2_m3ff2rc
power_type: D1indiv
power_type: D2indiv
power_type: D3indiv
power_type: indiv.mean
power_type: min1
power_type: min2
power_type: complete
1.00
0.75
0.50
0.25
0.00
Power
BF
BH
HO
None
MTP
Method
PowerUp
PUMP
Simulation


d_m: d3.2_m3rr2rc
power_type: D1indiv
power_type: D2indiv
power_type: D3indiv
power_type: indiv.mean
power_type: min1
power_type: min2
power_type: complete
1.00
0.75
0.50
0.25
0.00
Power
BF
BH
HO
None
MTP
Method
PowerUp
PUMP
Simulation

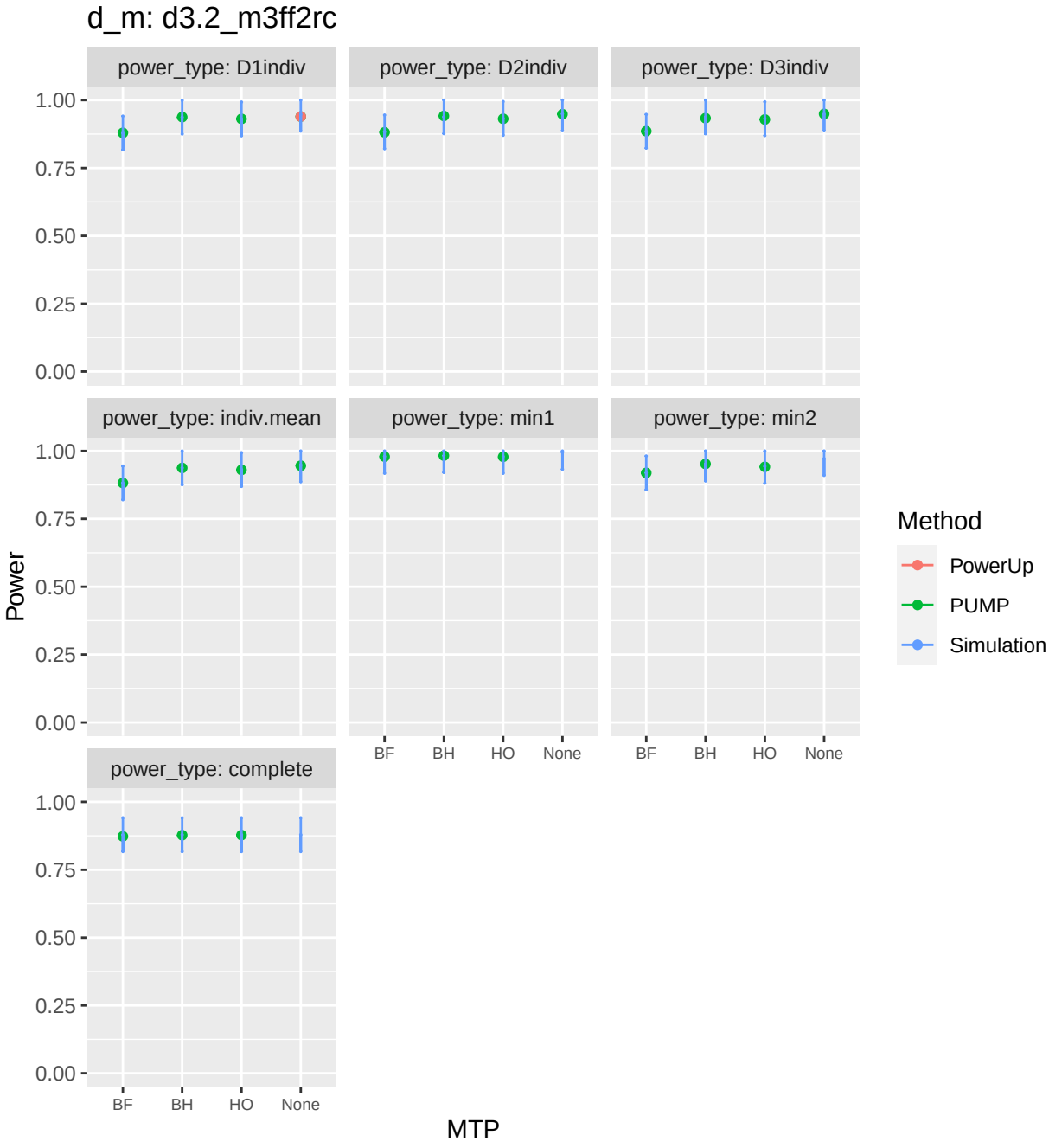
Varying R2

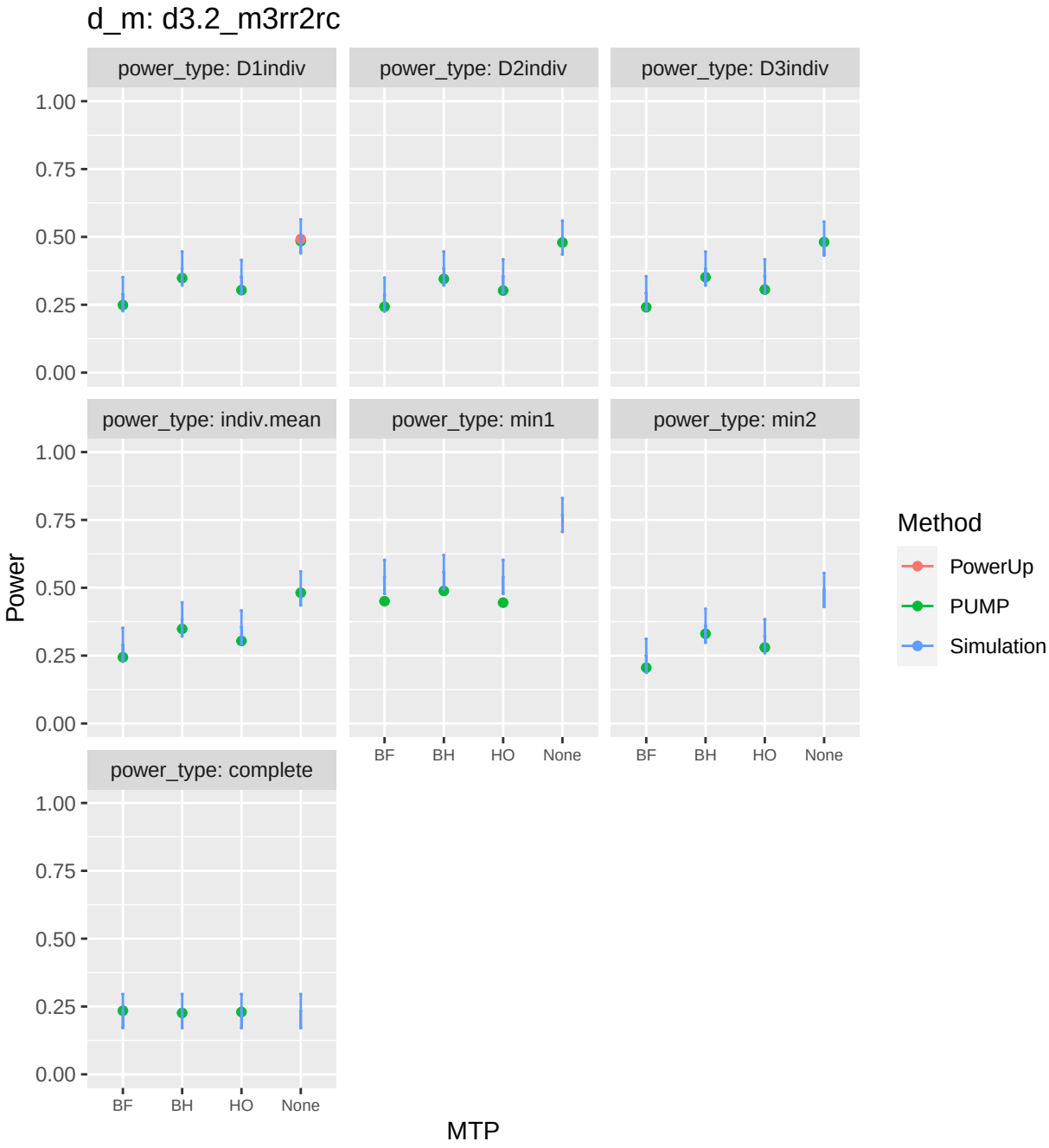
$R_1^2 = 0.6, 0.6, 0.6$



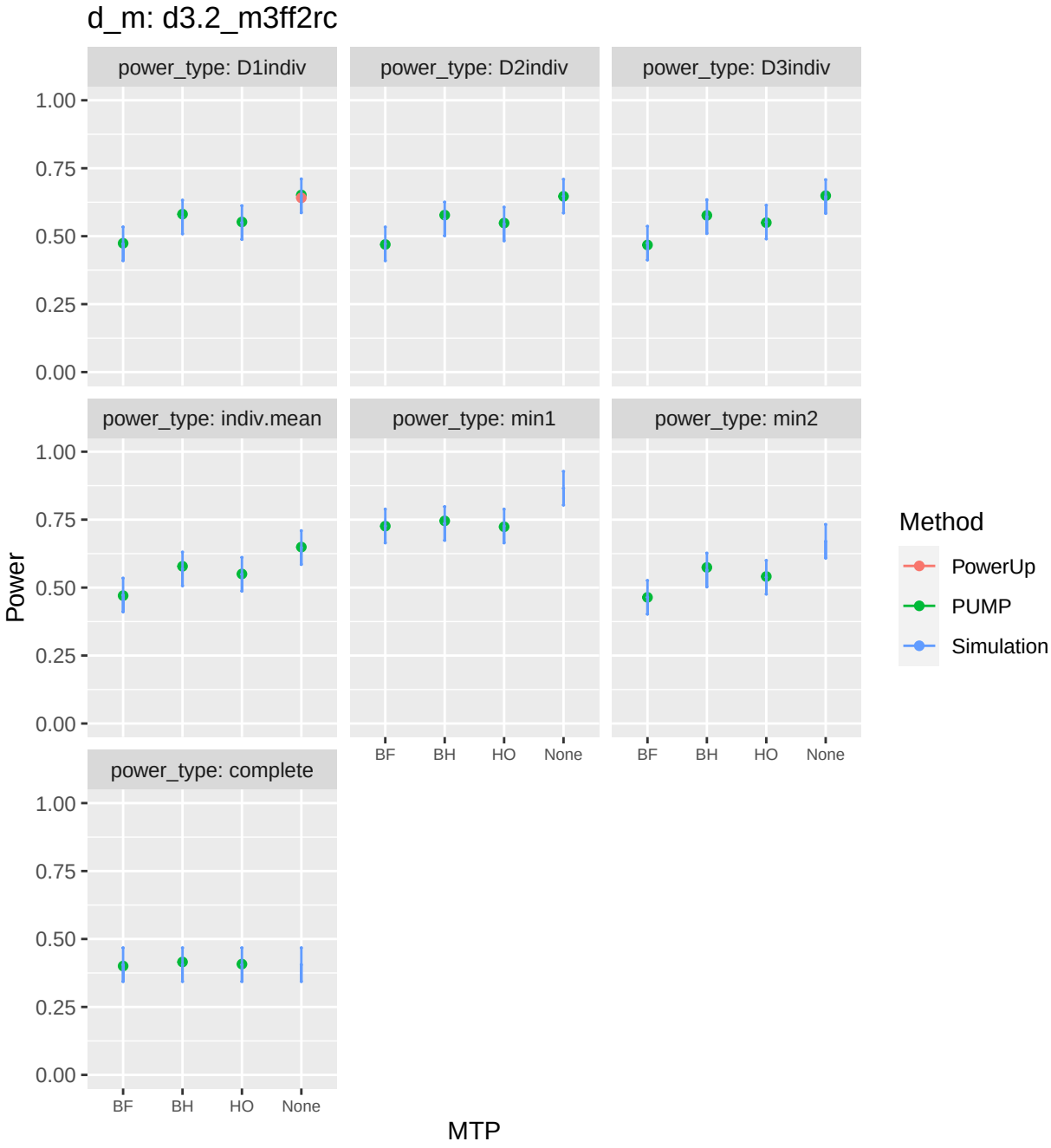

d_m: d3.2_m3rr2rc
power_type: D1indiv
power_type: D2indiv
power_type: D3indiv
power_type: indiv.mean
power_type: min1
power_type: min2
power_type: complete
Power
1.00
0.75
0.50
0.25
0.00
BF
BH
HO
None
MTP
Method
PowerUp
PUMP
Simulation

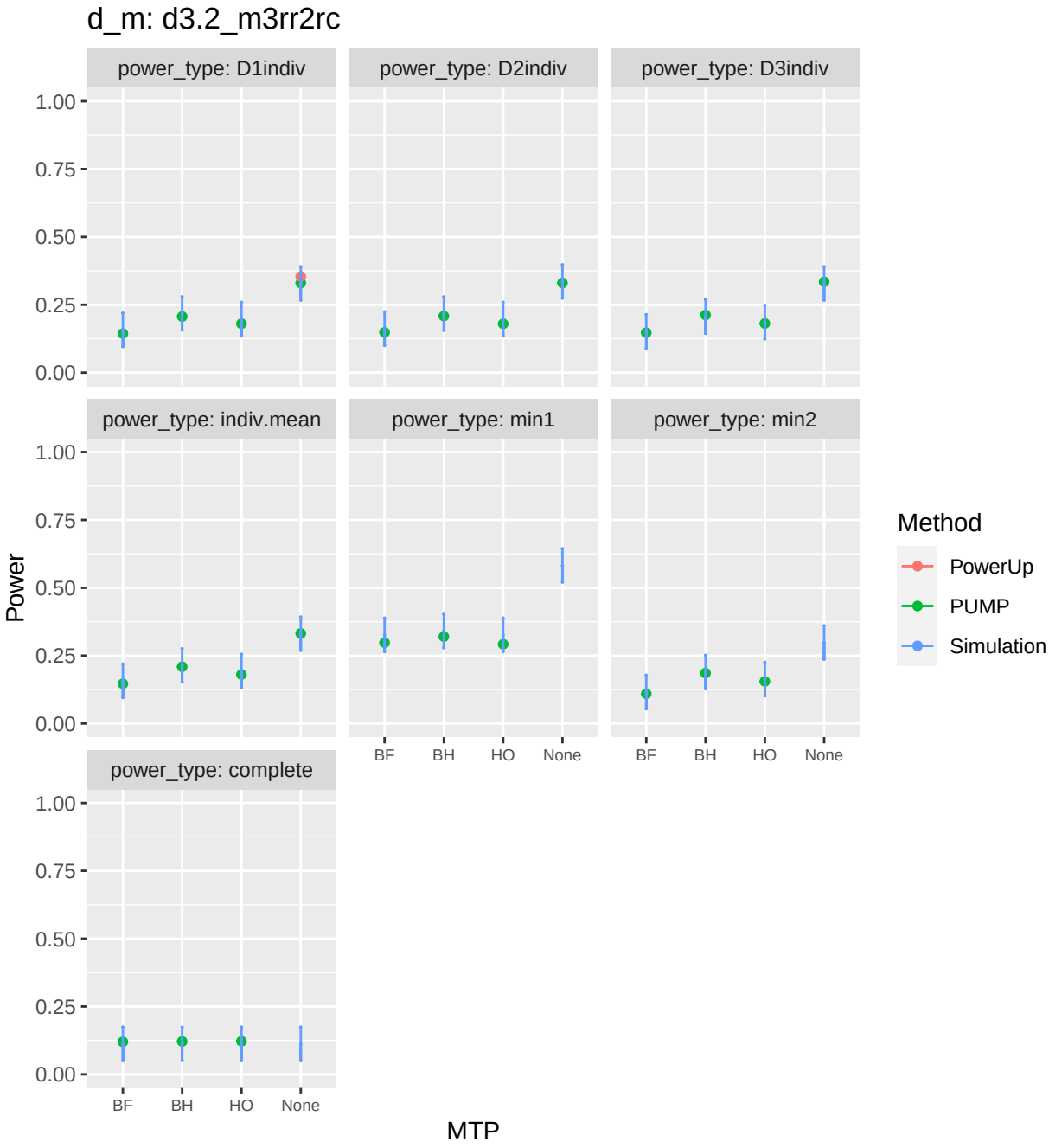
$R_2^2 = 0.6, 0.6, 0.6$


d_m: d3.2_m3ff2rc
power_type: D1indiv
power_type: D2indiv
power_type: D3indiv
power_type: indiv.mean
power_type: min1
power_type: min2
power_type: complete
1.00
0.75
0.50
0.25
0.00
Power
BF
BH
HO
None
MTP
Method
PowerUp
PUMP
Simulation


d_m: d3.2_m3rr2rc
power_type: D1indiv
power_type: D2indiv
power_type: D3indiv
power_type: indiv.mean
power_type: min1
power_type: min2
power_type: complete
1.00
0.75
0.50
0.25
0.00
Power
BF
BH
HO
None
MTP
Method
PowerUp
PUMP
Simulation

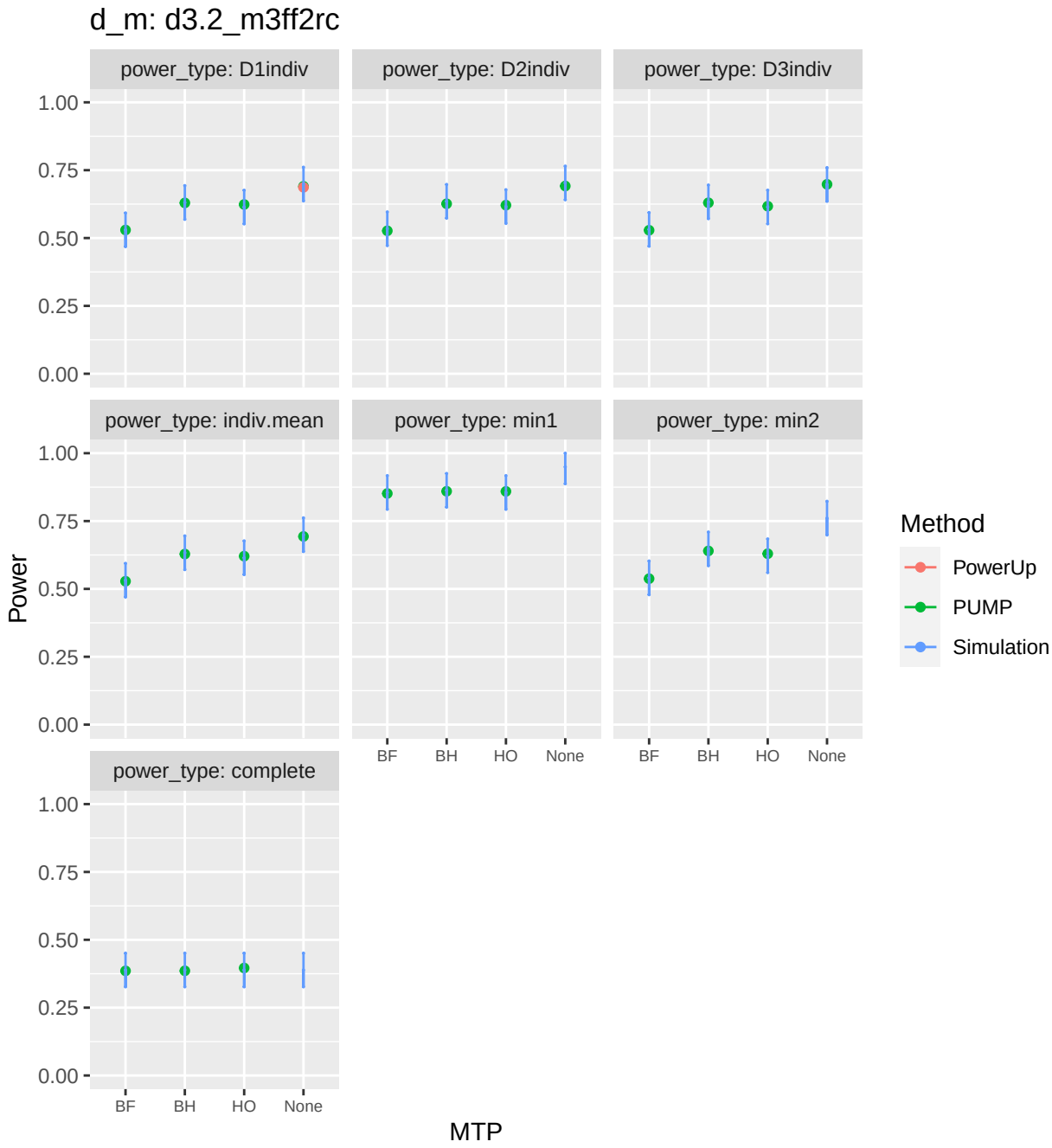
$R_1^2 = 0,\ 0,\ 0\ R_2^2 = 0,\ 0,\ 0$



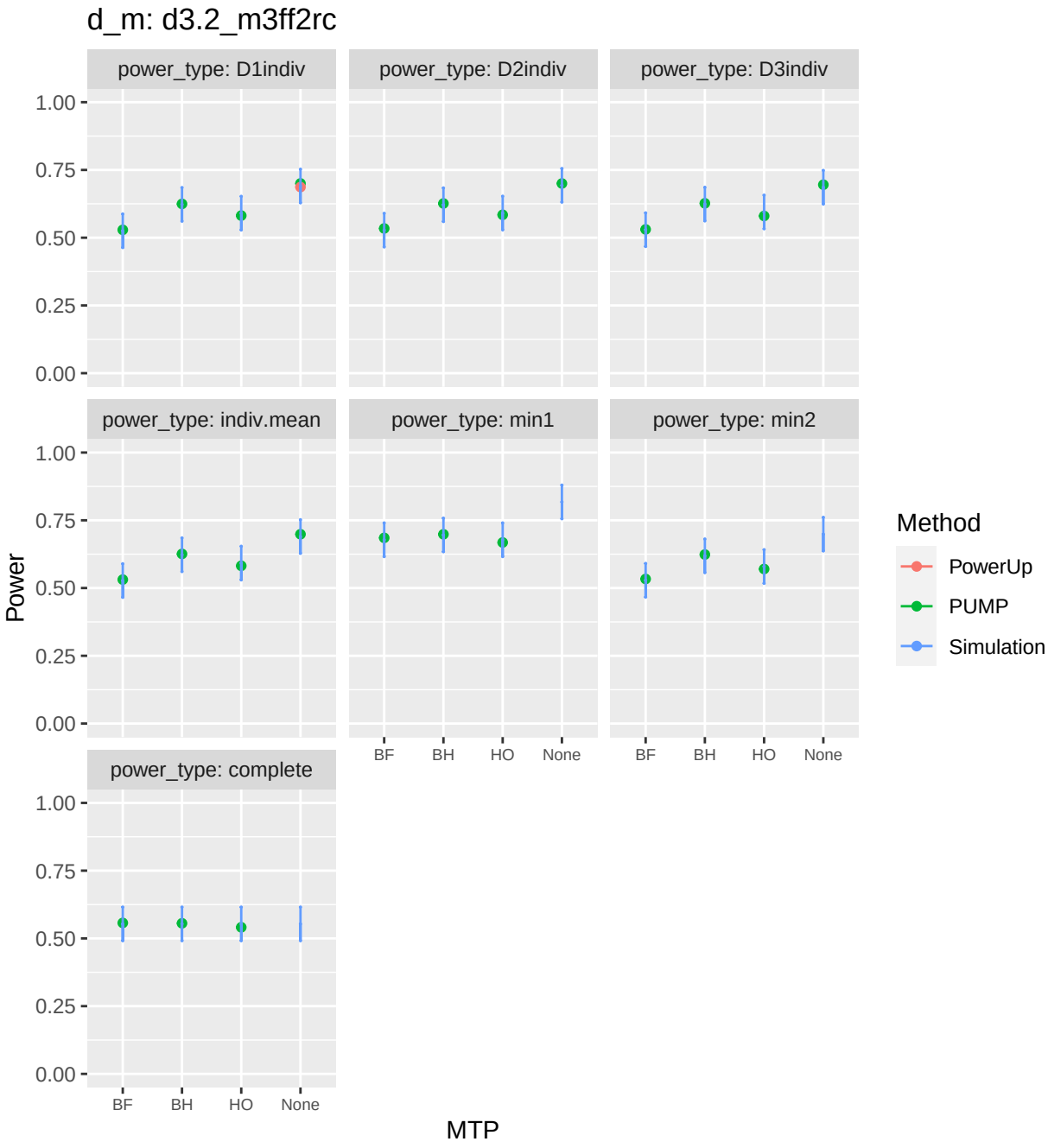

d_m: d3.2_m3rr2rc
power_type: D1indiv
power_type: D2indiv
power_type: D3indiv
power_type: indiv.mean
power_type: min1
power_type: min2
power_type: complete
1.00
0.75
0.50
0.25
0.00
Power
BF
BH
HO
None
MTP
Method
PowerUp
PUMP
Simulation

Varying rho

$\rho = 0.2$

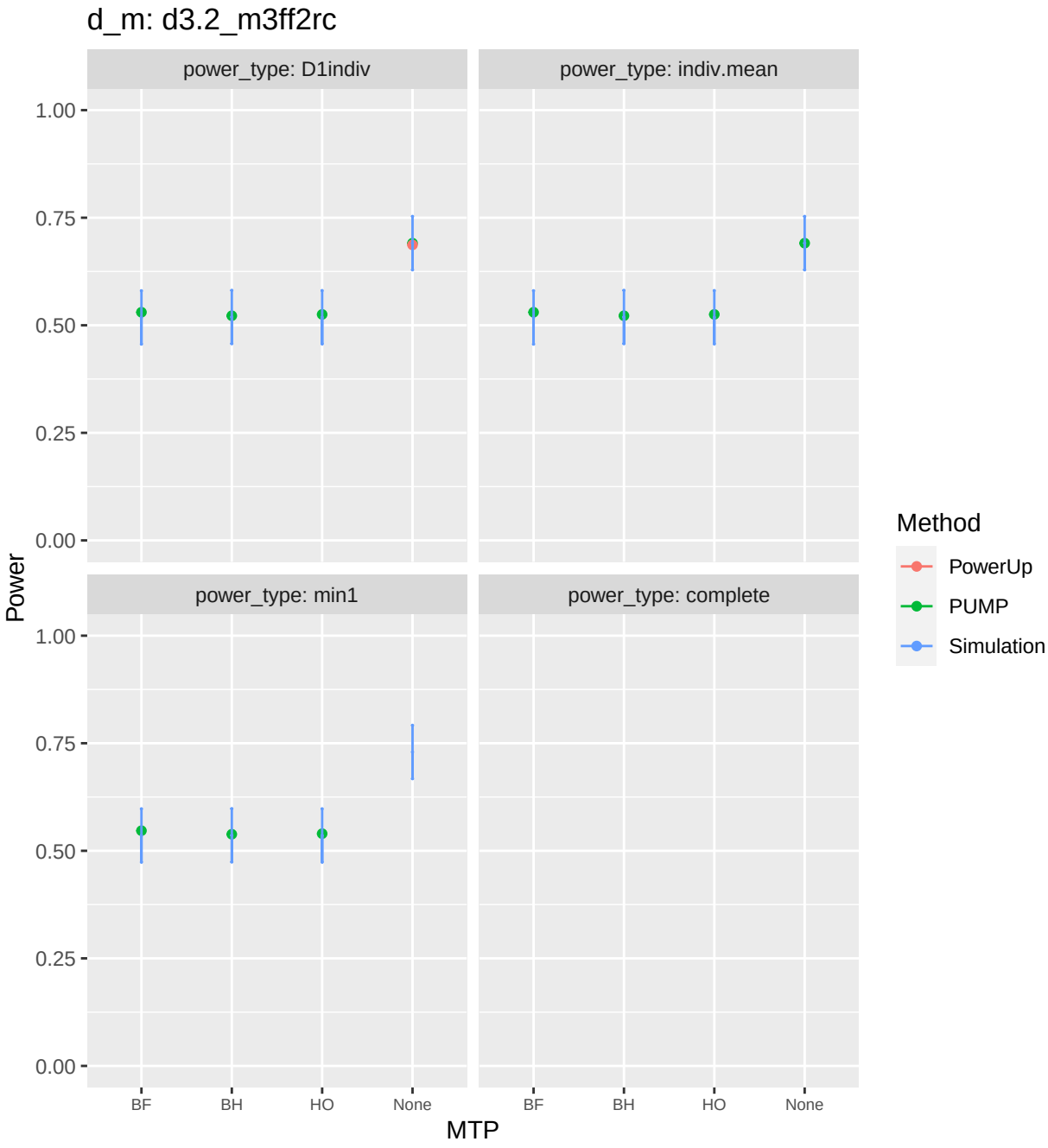


$\rho = 0.8$


d_m: d3.2_m3ff2rc
power_type: D1indiv
power_type: D2indiv
power_type: D3indiv
power_type: indiv.mean
power_type: min1
power_type: min2
power_type: complete
Power
1.00
0.75
0.50
0.25
0.00
BF
BH
HO
None
MTP
Method
PowerUp
PUMP
Simulation

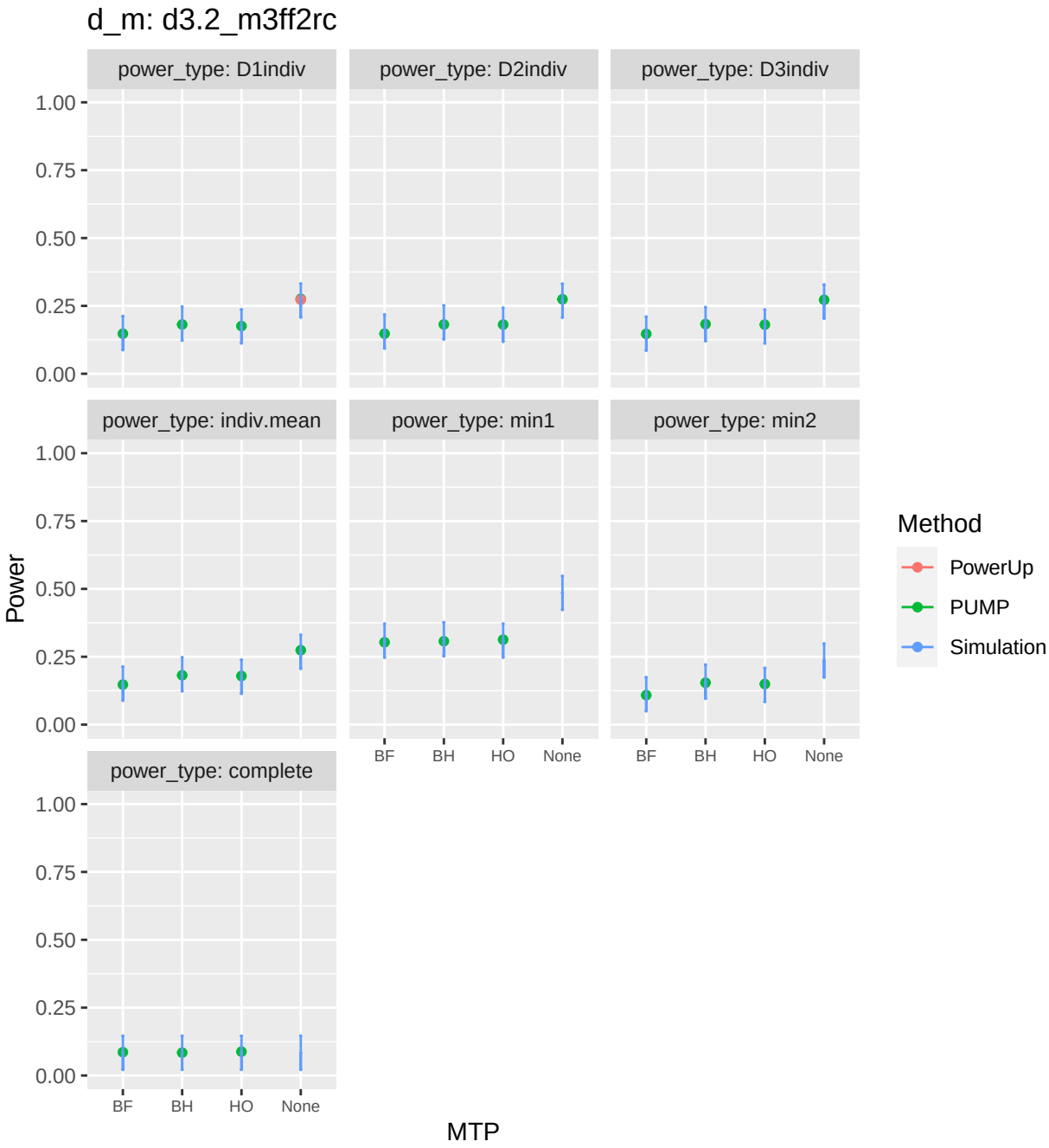
Varying true positives

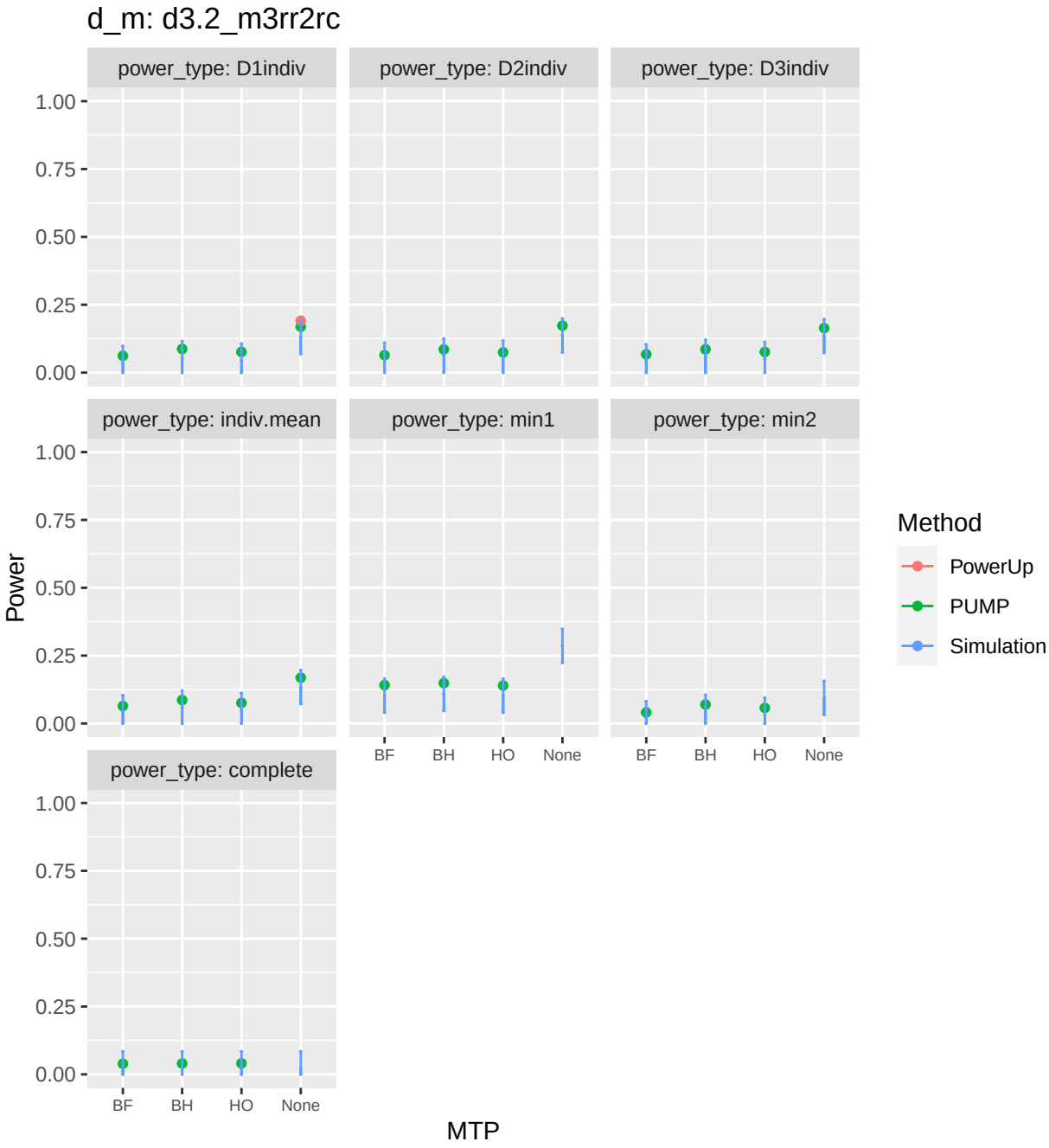
MDES = 0.125, 0, 0



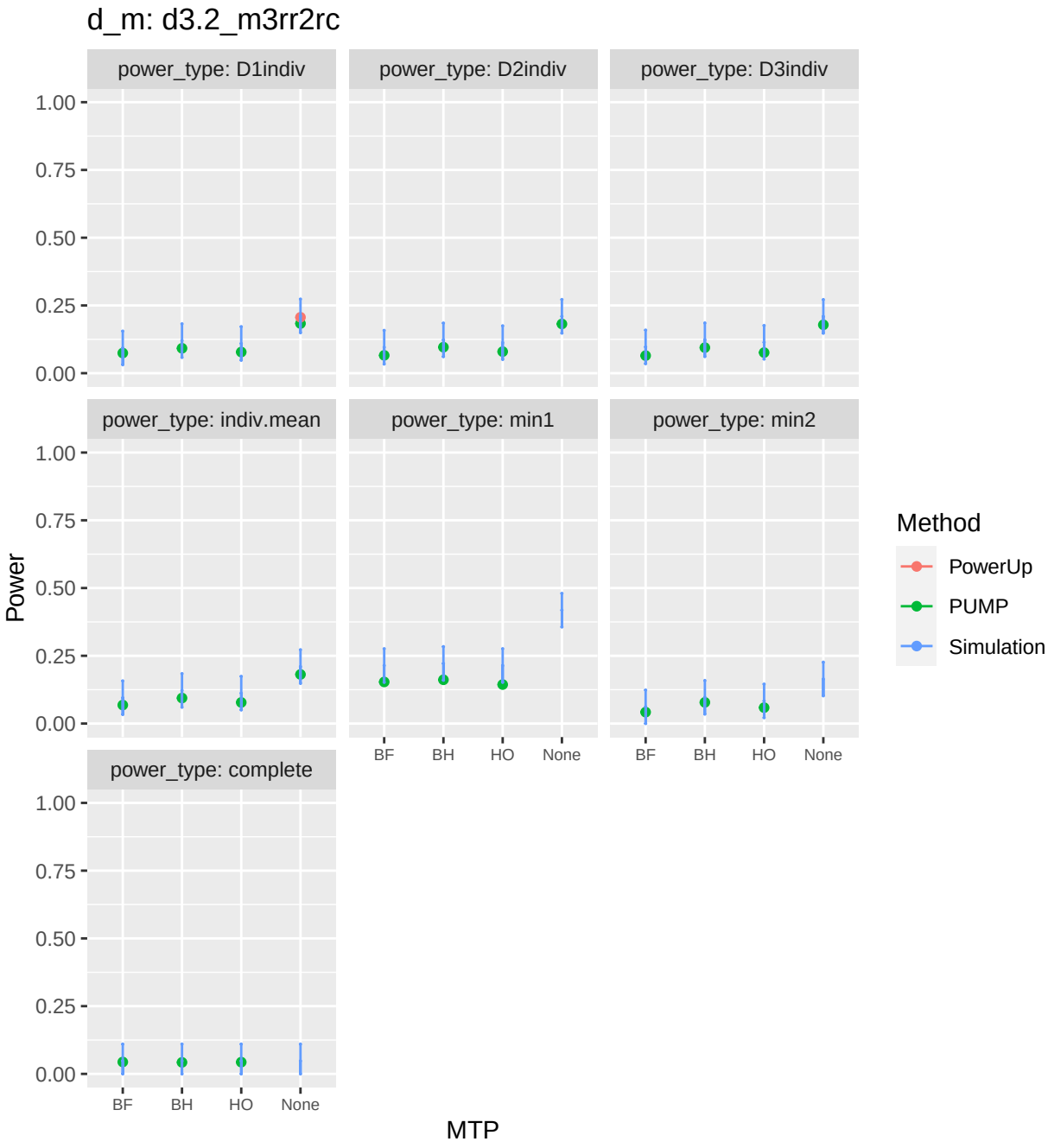
Varying ICC

$\text{ICC}_2 = 0.7, 0.7, 0.7$ $\text{ICC}_3 = 0.2, 0.2, 0.2$

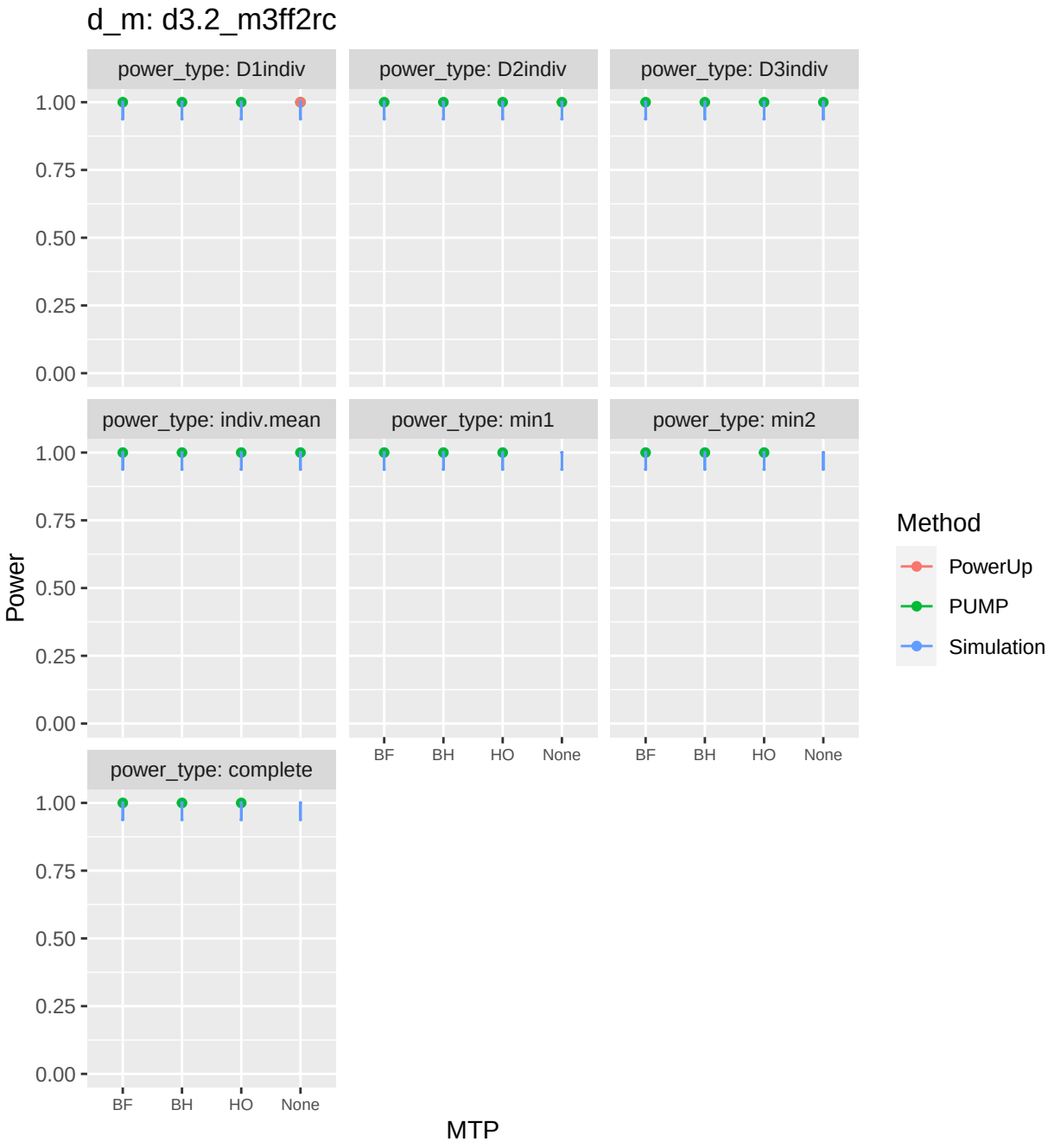


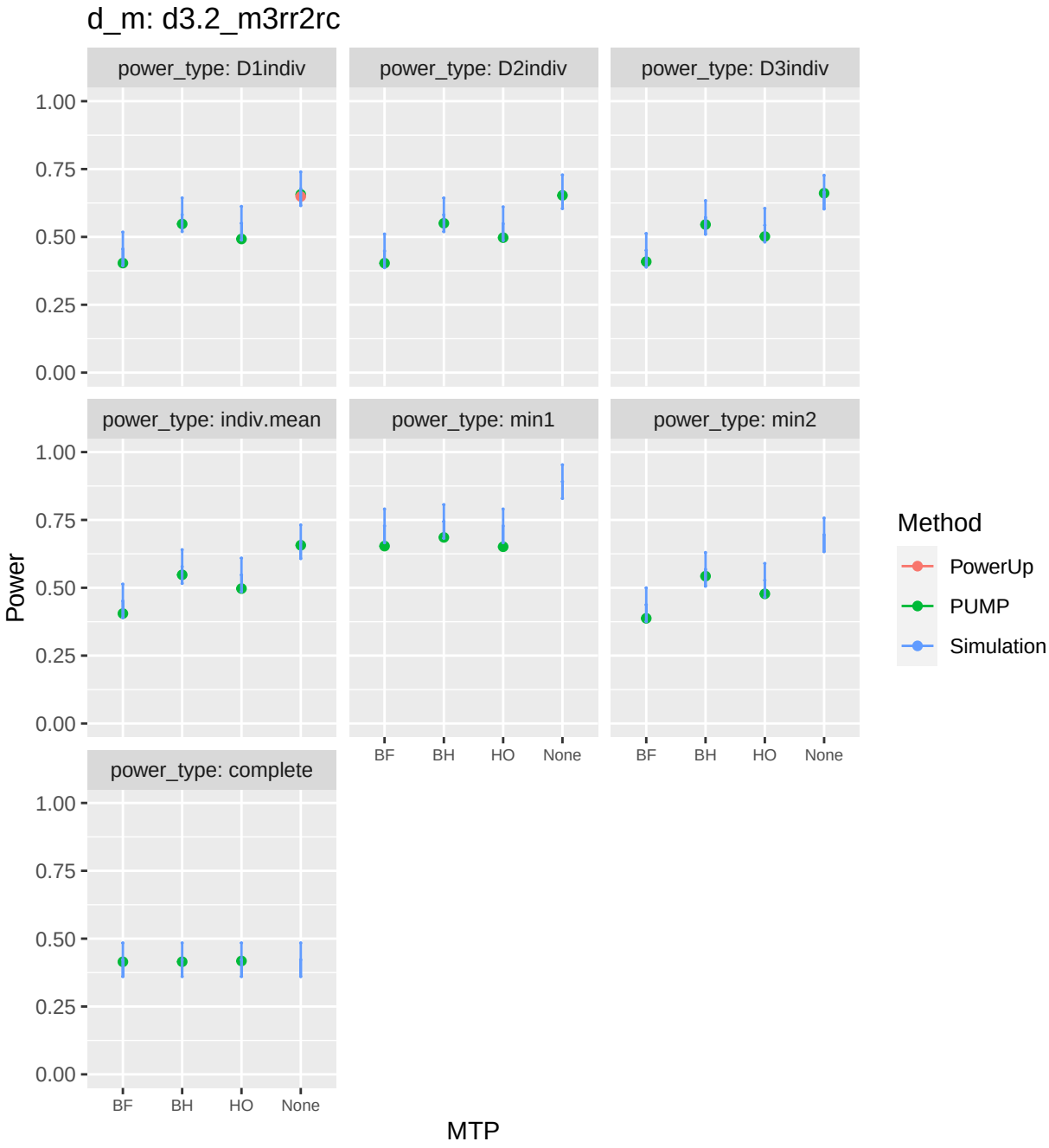

d_m: d3.2_m3rr2rc
power_type: D1indiv
power_type: D2indiv
power_type: D3indiv
power_type: indiv.mean
power_type: min1
power_type: min2
power_type: complete
Power
1.00
0.75
0.50
0.25
0.00
BF
BH
HO
None
MTP
Method
PowerUp
PUMP
Simulation

$\text{ICC}_2 = 0.2, 0.2, 0.2$ $\text{ICC}_3 = 0.7, 0.7, 0.7$

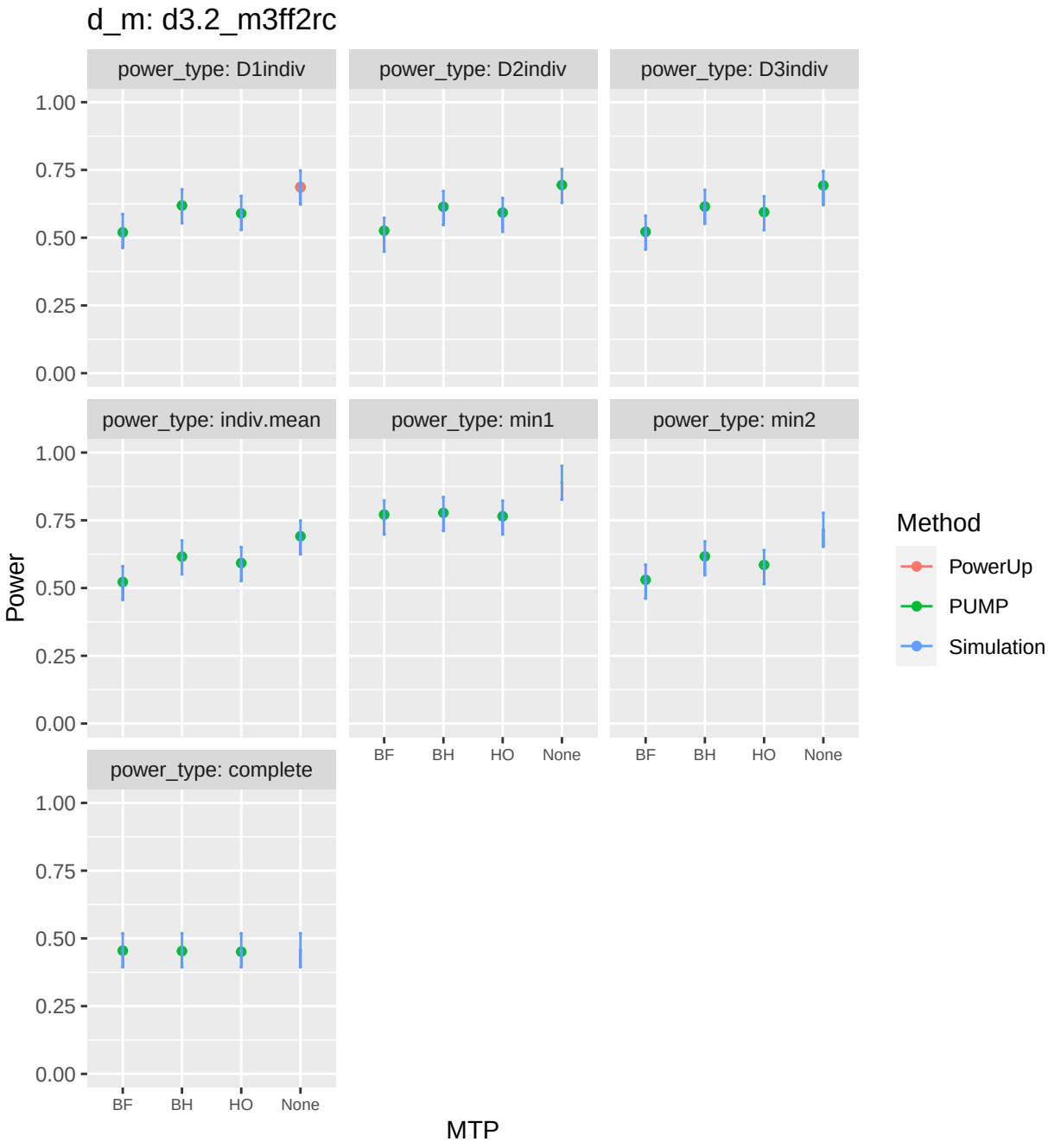


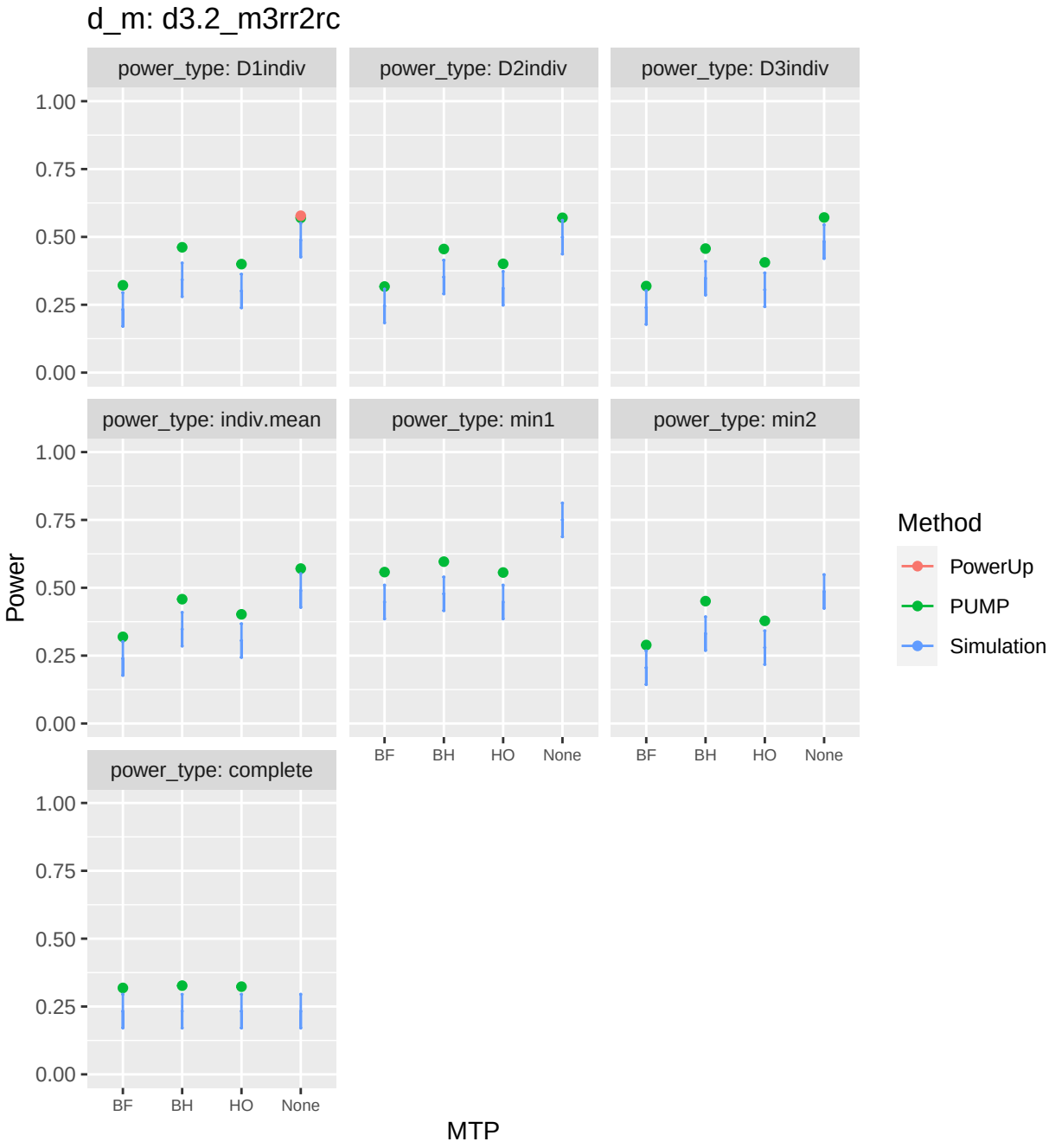
$\text{ICC}_2 = 0, 0, 0$ $\text{ICC}_3 = 0.2, 0.2, 0.2$




d_m: d3.2_m3rr2rc
power_type: D1indiv
power_type: D2indiv
power_type: D3indiv
power_type: indiv.mean
power_type: min1
power_type: min2
power_type: complete
1.00
0.75
0.50
0.25
0.00
Power
BF
BH
HO
None
MTP
Method
PowerUp
PUMP
Simulation

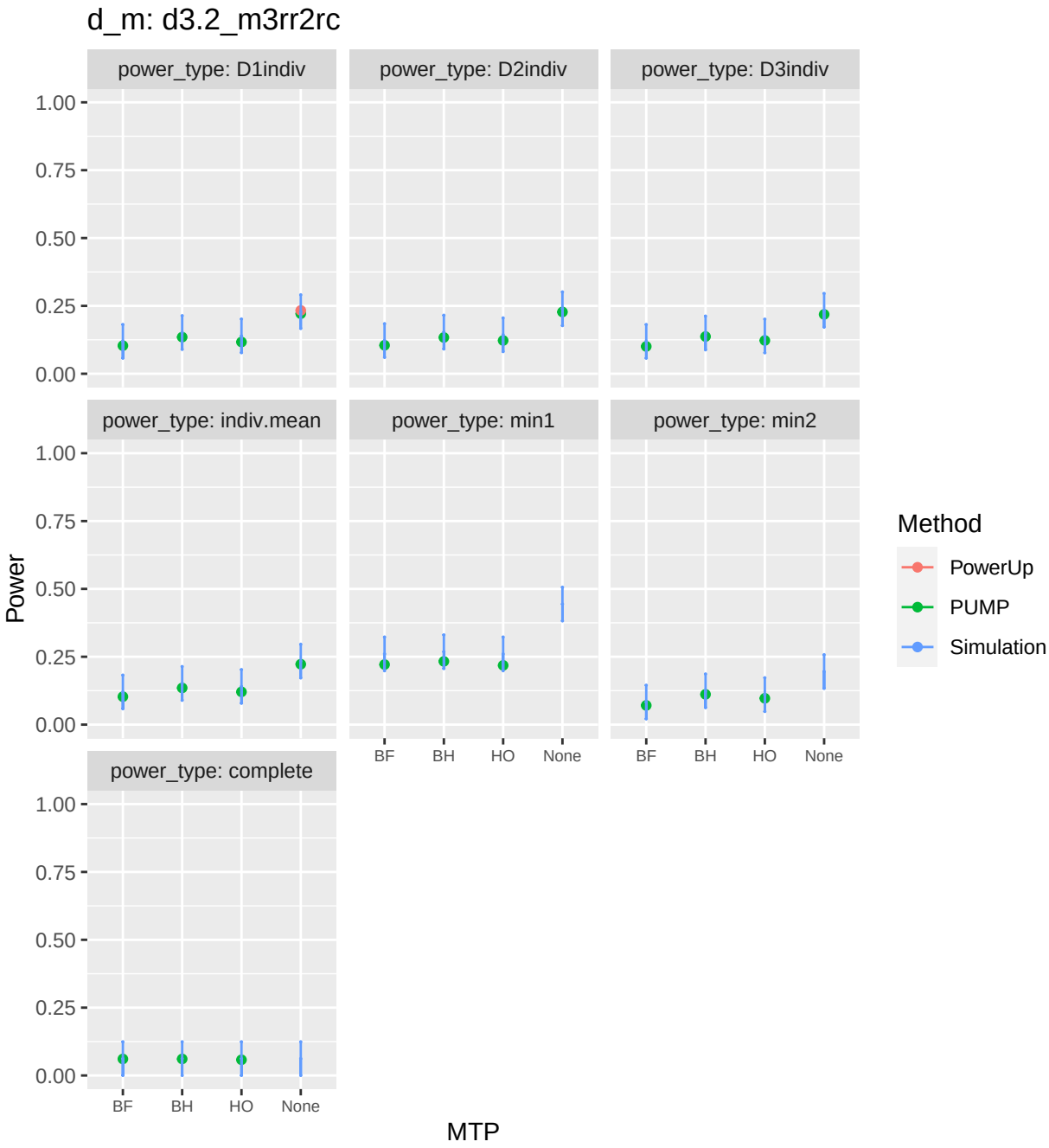
$\text{ICC}_2 = 0.2, 0.2, 0.2$ $\text{ICC}_3 = 0, 0, 0$



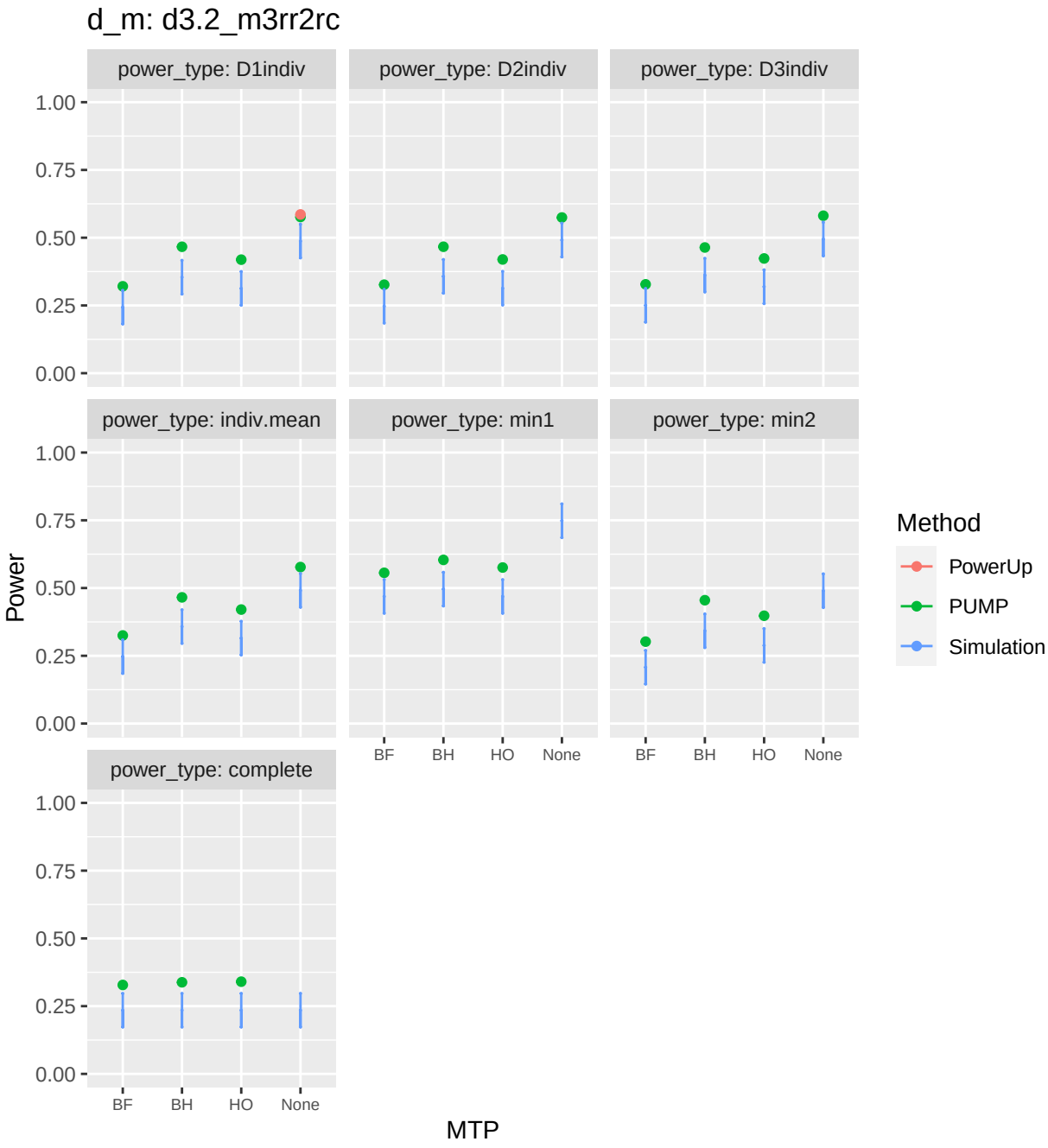

d_m: d3.2_m3rr2rc
power_type: D1indiv
power_type: D2indiv
power_type: D3indiv
power_type: indiv.mean
power_type: min1
power_type: min2
power_type: complete
Power
1.00
0.75
0.50
0.25
0.00
BF
BH
HO
None
MTP
Method
PowerUp
PUMP
Simulation

Varying Omega

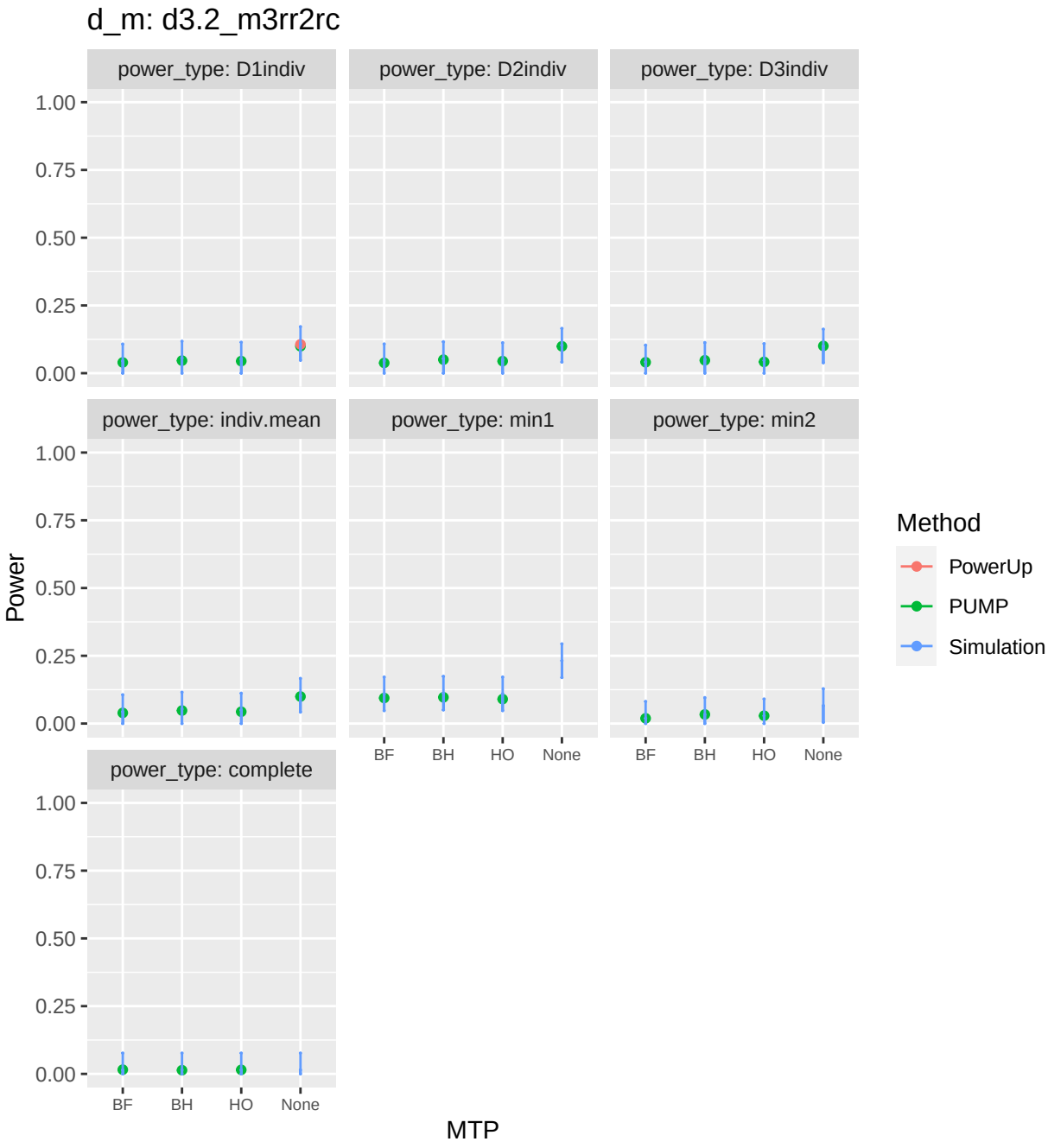
$\omega_3 = 0.8, 0.8, 0.8$



$\omega_3 = 0, 0, 0$ $\text{ICC}_3 = 0.2, 0.2, 0.2$



$\omega_3 = 0.8, 0.8, 0.8$ $\text{ICC}_3 = 0.7, 0.7, 0.7$



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  |
## +---------+----+----+-----+---------+---------+------+------+------+-------+-------+
```

```
## |    0    | 30 | 10 | 0.5 |   NA    |   0.1   | 0.1 | 0.1 |  NA  | 0.2 | 0.2 |
## +---------+----+----+-----+---------+---------+-----+-----+------+-----+-----+
```