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# **pypowerup**

***Release 0.1.0***

**Oct 10, 2020**



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# CHAPTER 1

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Authors

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## CHAPTER 2

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### PyPowerUp

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PyPowerUp is the Python implementation for the research article “PowerUp!: A Tool for Calculating Minimum Detectable Effect Sizes and Minimum Required Sample Sizes for Experimental and Quasi-experimental Design Studies (Dong & Maynard, 2013)”. It is a power analysis tool for 21 experimental and quasi-experimental designs.

Given study design, PyPowerUp computes minimum detectable effect sizes `effect_size`, power `power`, and minimum required samples sizes `sample_size`.

To install PyPowerUp, run this command in your terminal:

```
$ pip install pypowerup
```

To use the functions:

```
from pypowerup import effect_size, power, sample_size
```



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## Individual Random Assignment Designs

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### 3.1 Simple Individual Random Assignment (IRA)

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
simple	1	individual	1	NA

```
[1]: from pypowerup import effect_size, power, sample_size
```

```
[2]: # effect size, i.e., minimum detectable effect sizes (MDES):
effect_size(design='ira', n=787, power=0.8, alpha=0.05, two_tailed=True, p=0.5, r2l=0,
↪ g=0)
```

```
[2]: 0.19997988869985736
```

```
[3]: # sample size, i.e., minimum required samples sizes (MRSS):
sample_size(design='ira', es=0.2, power=0.8, alpha=0.05, two_tailed=True, p=0.5,
↪ r2l=0, g=0)
```

```
[3]: 787.0
```

```
[4]: # power
power(design='ira', es=0.2, n=787, alpha=0.05, two_tailed=True, p=0.5, r2l=0, g=0)
```

```
[4]: 0.8000799952735076
```

#### Parameters for IRA

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### Output validation with statsmodels

Here we used `statsmodels` with the same parameters to validate our model results. Note `nobs1` in `statsmodels` is the sample size for treatment group, which is half of the total sample size output from our model. Thus, we define `nobs1=787/2=393.5` in the models below.

```
[5]: from statsmodels.stats.power import TTestIndPower
```

```
[6]: # effect size
analysis = TTestIndPower()
analysis.solve_power(power=0.8, nobs1=393.5, ratio=1, alpha=0.05, alternative='two-
    sided')
```

```
[6]: 0.19997768751017836
```

```
[7]: # sample size (statsmodels output treatment sample size only, which is the half of
    our computed total sample size)
```

(continues on next page)



```

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```

### 3.2.2 BIRA2\_1f

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	2	individual	1	fixed

```

[5]: # effect size, i.e., minimum detectable effect sizes (MDES):
effect_size(design = "bira2_1f", n=10, J=200, power=0.8, alpha=0.05, two_tailed=True,
↪p=0.5, r21=0, g=0)

```

```

[5]: 0.1253671054395026

```

```

[6]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units.
sample_size(design = "bira2_1f", n=10, es=0.125, power=0.8, alpha=0.05, two_
↪tailed=True, p=0.5, r21=0, g=0)

```

[6]: 201.0

```
[7]: # power
power(design = "bira2_1f", n=10, J=200, es=0.125, alpha=0.05, two_tailed=True, p=0.5,
      ↪r21=0, g=0)
```

[7]: 0.7976961337604935

### Parameters for BIRA2\_1f

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```

### 3.2.3 BIRA2\_1r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	2	individual	1	random

```
[8]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "bira2_1r", n=80, J=480, rho2=0.35, omega2=0.1, power=0.8,
↪ alpha=0.05,
two_tailed=True, p=0.5, r21=0, r2t2=0, g=0)
```

```
[8]: 0.033290496240165834
```

```
[9]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units
sample_size(design = "bira2_1r", es=0.033290496240165834, n=80, rho2=0.35, omega2=0.1,
↪ power=0.8, alpha=0.05,
two_tailed=True, p=0.5, r21=0, r2t2=0, g=0)
```

```
[9]: 480.0
```

```
[10]: # power
power(design = "bira2_1r", es=0.033290496240165834, n=80, J=480, rho2=0.35, omega2=0.
↪ 1, alpha=0.05,
two_tailed=True, p=0.5, r21=0, r2t2=0, g=0)
```

```
[10]: 0.800001211704756
```

#### Parameters for BIRA2\_1r

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```

### 3.2.4 BIRA3\_1r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	3	individual	1	random

```

[11]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "bira3_1r", n=80, J=10, K=100, rho3=0.2, rho2=0.15, omega3=0.1,
→omega2=0.1,
        power=0.8, alpha=0.05, two_tailed=True, p=0.5, r21=0, r2t2=0, r2t3=0, g=0)

[11]: 0.04451381756409839

```

```
[12]: 100.0
```

```
[13]: 0.8000026614774113
```

### Parameters for BIRA3\_1r

[illegible]

```

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```

### 3.2.5 BIRA4\_1r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	4	individual	1	random

```

[14]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "bira4_1r", n=10, J=4, K=4, L=20, rho4=0.05, rho3=0.15, rho2=0.
↪ 15,
        omega4=0.5, omega3=0.5, omega2=0.5, r21=0.5, r2t2=0.5, r2t3=0.5, r2t4=0.5,
↪ g=1,
        power=0.8, alpha=0.05, two_tailed=True
        )
[14]: 0.1191537036343213

```

```
[15]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 4 units
sample_size(design = "bira4_1r", es=0.1191537036343213, n=10, J=4, K=4, rho4=0.05,
→ rho3=0.15, rho2=0.15,
      omega4=0.5, omega3=0.5, omega2=0.5, r21=0.5, r2t2=0.5, r2t3=0.5, r2t4=0.5,
→ g=1,
      power=0.8, alpha=0.05, two_tailed=True)
```

```
[15]: 20.0
```

```
[16]: # power
power(design = "bira4_1r", es=0.1191537036343213, n=10, J=4, K=4, L=20, rho4=0.05,
→ rho3=0.15, rho2=0.15,
      omega4=0.5, omega3=0.5, omega2=0.5, r21=0.5, r2t2=0.5, r2t3=0.5, r2t4=0.5,
→ g=1,
      alpha=0.05, two_tailed=True)
```

```
[16]: 0.8000404338335202
```

### Parameters for BIRA4\_1r

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Cluster Random Assignment Designs

---

## 4.1 Simple Cluster Random Assignment (CRA)

### 4.1.1 CRA2\_2r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
simple	2	cluster	2	random

```
[1]: from pypowerup import effect_size, sample_size, power
```

```
[2]: # effect size, i.e., minimum detectable effect sizes (MDES):
effect_size(design='cra2_2r', rho2=0.15, r21=0.40, r22=0.53, g=1, n=100, J=40,
           alpha=0.05, power=0.8, p=0.5)
```

```
[2]: 0.2502054873913746
```

```
[3]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units.
sample_size(design='cra2_2r', es=0.2502054873913746, rho2=0.15, r21=0.40, r22=0.53,
           g=1, n=100, alpha=0.05, power=0.8, p=0.5)
```

```
[3]: 40.0
```

```
[4]: # power
power(design='cra2_2r', es=0.2502054873913746, rho2=0.15, r21=0.40,
     r22=0.53, g=1, n=100, J=40, alpha=0.05, p=0.5)
```

```
[4]: 0.8000094900703394
```

#### Parameters for CRA2\_2r

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```
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### 4.1.2 CRA3\_3r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
simple	3	cluster	3	random

```
[5]: # effect size, i.e., minimum detectable effect sizes (MDES):
effect_size(design='cra3_3r', rho3=0.38, rho2=0.10, r21=0.37, r22=0.53,
            r23=0.87, g=1, n=20, J=2, K=66, alpha=0.05, power=0.8, p=0.5)

[5]: 0.19949475029929953
```

```
[6]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units.
sample_size(design='cra3_3r', es=0.19949475029929953, rho3=0.38,
            rho2=0.10, r21=0.37, r22=0.53, r23=0.87, g=1, n=20, J=2,
            alpha=0.05, power=0.8, p=0.5)

[6]: 66.0
```

```
[7]: # power
power(design='cra3_3r', es=0.19949475029929953, rho3=0.38, rho2=0.10, r21=0.37,
      r22=0.53, r23=0.87, g=1, n=20, J=2, K=66, alpha=0.05, p=0.5)

[7]: 0.8000043161361032
```

#### Parameters for CRA3\_3r

Parameters	effect_size	sample_size	power
design	latest	latest	latest
rho3	0.38	0.38	0.38
rho2	0.10	0.10	0.10
r21	0.37	0.37	0.37
r22	0.53	0.53	0.53
r23	0.87	0.87	0.87
g	1	1	1
n	20	20	20
J	2	2	2
K	66	66	66
alpha	0.05	0.05	0.05
power	0.8	0.8	0.8
p	0.5	0.5	0.5

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/td >< td >< /td >< /tr >
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```

### 4.1.3 CRA4\_4r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
simple	4	cluster	4	random

```

[8]: # effect size, i.e., minimum detectable effect sizes (MDES):
effect_size(design='cra4_4r', rho4=0.05, rho3=0.05, rho2=0.10, r21=0.50, r22=0.50,
           r23=0.50, r24=0.50, g=1, n=10, J=2, K=3, L=20,
           alpha=0.05, power=0.8, p=0.5)

```

```

[8]: 0.29231230598875796

```

```
[9]: 20.0
```

```
[10]: 0.800046080238779
```

[illegible]

```

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```

## 4.2 Blocked (Stratified) Cluster Randomized Assignment (BCRA)

### 4.2.1 BCRA3\_2f

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	3	cluster	2	fixed

```
[1]: from pypowerup import effect_size, sample_size, power
```

```
[2]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design='bcra3_2f', rho2=0.10, r21=0.50, r22=0.50, g=1, n=20, J=44, K=5)
```

```
[2]: 0.10219354337360606
```

```
[3]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design='bcra3_2f', es=0.10219354337360606, rho2=0.10, r21=0.50, r22=0.50, ↵
↵g=1, n=20, J=44)
```

```
[3]: 5.0
```

```
[4]: # power
power(design='bcra3_2f', es=0.10219354337360606, rho2=0.10, r21=0.50, r22=0.50, g=1, ↵
↵n=20, J=44, K=5)
```

```
[4]: 0.8000016066584502
```

Parameters
effect <sub>s</sub> ize
sample <sub>s</sub> ize
power
design
es
160;
n
J
K
160;
power
alpha
two - tailed

[illegible]

#### 4.2.2 BCRA3\_2r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	3	cluster	2	random

```
[5]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design='bcra3_2r', rho3=0.38, rho2=0.10, omega3=0.50, r21=0.37,
            r22=0.53, r2t3=0, g=0, n=20, J=2, K=64)

[5]: 0.20020041517111645

[6]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design='bcra3_2r', es=0.20020041517111645, rho3=0.38, rho2=0.10, omega3=0.50,
            r21=0.37,
            r22=0.53, r2t3=0, g=0, n=20, J=2)

[6]: 64.0

[7]: # power
power(design='bcra3_2r', es=0.20020041517111645, rho3=0.38, rho2=0.10, omega3=0.50,
      r21=0.37,
      r22=0.53, r2t3=0, g=0, n=20, J=2, K=64)

[7]: 0.8000043161361032
```

	Parameters	
	<code>effect.size</code>	
	<code>sample.size</code>	





```

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/ttd >< /td >< /td >< /tr >
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```

## 4.2.3 BCRA4\_2r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	4	cluster	2	random

```

[8]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design='bcra4_2r', rho4=0.05, rho3=0.15, rho2=0.15, omega4=0.5, omega3=0.
↪5, r21=0.5, r22=0.5,
      r2t3=0.5, r2t4=0.5, g=0, n=10, J=4, K=4, L=20)

```

```
[8]: 0.14584081061169768
```

```

[9]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 4 units
sample_size(design='bcra4_2r', es=0.14584081061169768, rho4=0.05, rho3=0.15, rho2=0.
↪15, omega4=0.5, omega3=0.5, r21=0.5, r22=0.5,
      r2t3=0.5, r2t4=0.5, g=0, n=10, J=4, K=4)

```

```
[9]: 20.0
```

```

[10]: # power
power(design='bcra4_2r', es=0.14584081061169768, rho4=0.05, rho3=0.15, rho2=0.15,
↪omega4=0.5, omega3=0.5, r21=0.5, r22=0.5,
      r2t3=0.5, r2t4=0.5, g=0, n=10, J=4, K=4, L=20)

```

```
[10]: 0.8000357933435768
```

```

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```

## 4.2.4 BCRA4\_3f

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	4	cluster	3	fixed

```

[11]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design='bcra4_3f', rho3=0.15, rho2=0.15, r21=0.5, r22=0.5,
           r23=0.5, g=2, n=10, J=4, K=4, L=15)

```

```
[11]: 0.2399780453218905
```

```

[12]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 4 units
sample_size(design='bcra4_3f', es=0.2399780453218905, rho3=0.15, rho2=0.15, r21=0.5,
           ↪r22=0.5,
           r23=0.5, g=2, n=10, J=4, K=4)

```

```
[12]: 15.0
```

```

[13]: # power
power(design='bcra4_3f', es=0.2399780453218905, rho3=0.15, rho2=0.15, r21=0.5, r22=0.
   ↪5,
           r23=0.5, g=2, n=10, J=4, K=4, L=15)

```

```
[13]: 0.8000158353898167
```

```

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```

#### 4.2.5 BCRA4\_3r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	4	cluster	3	random

```

[14]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design='bcra4_3r', rho4=0.05, rho3=0.15, rho2=0.15, omega4=0.5,
           r21=0.5, r22=0.5, r23=0.5, r2t4=0.5, g=3, n=10, J=4, K=20, L=20)

```

```

[14]: 0.12100407246925271

```

```

[15]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 4 units
sample_size(design='bcra4_3r', es=0.12100407246925271, rho4=0.05, rho3=0.15, rho2=0.
↪15, omega4=0.5,
           r21=0.5, r22=0.5, r23=0.5, r2t4=0.5, g=3, n=10, J=4, K=20)

```

```

[15]: 20.0

```

```

[16]: # power
power(design='bcra4_3r', es=0.12100407246925271, rho4=0.05, rho3=0.15, rho2=0.15,
↪omega4=0.5,
      r21=0.5, r22=0.5, r23=0.5, r2t4=0.5, g=3, n=10, J=4, K=20, L=20)

```

```

[16]: 0.800053034680572

```

```

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```

## Quasi-experimental Designs

## 5.1 Regression Discontinuity (RD)

## 5.1.1 RD2\_1f

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	2	individual	1	fixed

```
[1]: from pypowerup import effect_size, sample_size, power
```

```
[2]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "rd2_1f", n=55, J=20, r21=0.5, g=1, design_effect=2.75)
```

```
[2]: 0.19828457764454652
```

```
[3]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units
sample_size(design = "rd2_1f", es=0.19828457764454652, n=55, r21=0.5, g=1, design_
↪effect=2.75)
```

```
[3]: 20.0
```

```
[4]: # power
power(design = "rd2_1f", es=0.19828457764454652, n=55, r21=0.5, J=20, g=1, design_
↪effect=2.75)
```

```
[4]: 0.8000010686602212
```

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```

```

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```

### 5.1.2 RD2\_1r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	2	individual	1	random



```
[5]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "rd2_1r", n=50, J=40, r21=0.5, g=1, r2t2=0.1, omega2=0.2, rho2=
↪0.15, design_effect=2.75)
```

```
[5]: 0.15782962225367275
```

```
[6]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units
sample_size(design = "rd2_1r", es=0.15782962225367275, n=50, r21=0.5, g=1,
r2t2=0.1, omega2=0.2, rho2= 0.15, design_effect=2.75)
```

```
[6]: 40.0
```

```
[7]: # power
power(design = "rd2_1r", es=0.15782962225367275, n=50, J=40, r21=0.5, g=1,
r2t2=0.1, omega2=0.2, rho2= 0.15, design_effect=2.75)
```

```
[7]: 0.8000090684884187
```

Parameters
effect_size
sample_size
power
design
es
160;
n
J
160;
power
160;
alpha
two-tailed

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```

### 5.1.3 RDC\_2r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
simple	2	cluster	2	random

```

[8]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design="rdc_2r", rho2=0.15, r21=0.5, r22=0.5, g=1, n=55, J=179, design_
↪effect=2.75)

```

```

[8]: 0.20086870136611698

```

```

[9]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units
sample_size(design="rdc_2r", es=0.20086870136611698, rho2=0.15, r21=0.5,
r22=0.5, g=1, n=55, design_effect=2.75)

```

```

[9]: 179.0

```

```

[10]: # power
power(design="rdc_2r", es=0.20086870136611698, rho2=0.15, r21=0.5,
r22=0.5, g=1, n=55, J=179, design_effect=2.75)

```

```

[10]: 0.8000017574724924

```

```

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```



### 5.1.4 RDC\_3r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
simple	3	cluster	3	random

```
[11]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "rdc_3r", rho3=0.15, rho2=0.15, r21=0.5, r22=0.5,
           r23=0.5, g=1, n=18, J=3, K=230, design_effect=2.75)
```

```
[11]: 0.20079075638849297
```

```
[12]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 2 units
sample_size(design = "rdc_3r", es=0.20079075638849297, rho3=0.15, rho2=0.15, r21=0.5,
           ↪r22=0.5,
           r23=0.5, g=1, n=18, J=3, design_effect=2.75)
```

```
[12]: 230.0
```

```
[13]: # power
power(design = "rdc_3r", es=0.20079075638849297, rho3=0.15, rho2=0.15, r21=0.5, r22=0.
↪5,
           r23=0.5, g=1, n=18, J=3, K=230, design_effect=2.75)
```

```
[13]: 0.8000015459112233
```

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```

### 5.1.5 RD2\_3f

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	3	cluster	2	fixed

```

[14]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "rd3_2f", rho2=0.15, r21=0.5, r22=0.5, g=0, n=18, J=3, K=71,
↪ design_effect=2.75)

```

[14]: 0.20131125779908843

```
[15]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design = "rd3_2f", es=0.20131125779908843, rho2=0.15, r21=0.5, r22=0.5,
↪g=0,
        n=18, J=3, design_effect=2.75)
```

[15]: 71.0

```
[16]: # power
power(design = "rd3_2f", es=0.20131125779908843, rho2=0.15, r21=0.5, r22=0.5, g=0,
        n=18, J=3, K=71, design_effect=2.75)
```

[16]: 0.8000020062425997

Parameters
effect <sub>size</sub>
sample <sub>size</sub>
power
design
es
n
J
K
power
alpha
two-tailed

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```

### 5.1.6 RD2\_3r

Assignment	Clustering Level	Treatment Assignment	Treatment Level	Cluster Effect
blocked	3	cluster	2	random

```
[17]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "rdc_3r", rho3=0.15, rho2=0.15, r21=0.5, r22=0.5, r23=0.5,
           g=1, n=18, J=3, K=230, design_effect=2.75)
```

```
[17]: 0.20079075638849297
```

```
[18]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design = "rdc_3r", es=0.20079075638849297, rho3=0.15, rho2=0.15, r21=0.5,
           ↪r22=0.5, r23=0.5,
           g=1, n=18, J=3, design_effect=2.75)
```

```
[18]: 230.0
```

```
[19]: # power
power(design = "rdc_3r", es=0.20079075638849297, rho3=0.15, rho2=0.15, r21=0.5, r22=0.
   ↪5, r23=0.5,
       g=1, n=18, J=3, K=230, design_effect=2.75)
```

```
[19]: 0.8000015459112233
```

```
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```

## 5.2 Interrupted Time-Series (ITS)

Assign- ment	Clustering Level	Treatment ment	Assign- ment	Treatment Level	Cluster Effect
blocked	3	cluster		2	constant at level 3 random at level 2

```
[1]: from pypowerup import effect_size, sample_size, power
```

### No comparison units

```
[2]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "its_nocompare", rho2=0.03, T=5, n=75, K=10, r22=0, tf=2, g=0)
```

```
[2]: 0.3658177052373508
```

```
[3]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design = "its_nocompare", es=0.3658177052373508, rho2=0.03, T=5, n=75,
↪r22=0, tf=2, g=0)
```

```
[3]: 10.0
```

```
[4]: # power
power(design = "its_nocompare", es=0.3658177052373508, rho2=0.03, T=5, n=75, K=10,
↪r22=0, tf=2, g=0)
```

```
[4]: 0.8000060699483386
```

```
<table border="1" class="docutils"> <colgroup> <col width="32<col width="26<col width="26<col
width="16</colgroup> <thead valign="bottom"> <tr class="row-odd"><th class="head">Parameters</th>
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aclass = "hoverxreftooltipreferenceinternal" data - doc = "parameters" data - docpath =
```

## Chapter 5. Quasi-experimental Designs

```
[5]: # effect size, i.e., minimum detectable effect sizes (MDES)
effect_size(design = "its_wcompare", rho2=0.03, T=5, n=75, K=10, r22=0, tf=2, g=0, q=2)
```

```
[5]: 0.44803335835368546
```

```
[6]: # sample_size, i.e., minimum required samples sizes (MRSS) for level 3 units
sample_size(design = "its_wcompare", es=0.44803335835368546, rho2=0.03, T=5, n=75,
↪r22=0, tf=2, g=0, q=2)
```

```
[6]: 10.0
```

```
[7]: # power
power(design = "its_wcompare", es=0.44803335835368546, rho2=0.03, T=5, n=75, K=10,
↪r22=0, tf=2, g=0, q=2)
```

```
[7]: 0.8000060699483386
```

Parameters	effect <sub>s</sub> ize	sample <sub>s</sub> ize	power
design	its_wcompare	its_wcompare	its_wcompare
rho2	0.03	0.03	0.03
T	5	5	5
n	75	75	75
K	10	10	10
r22	0	0	0
tf	2	2	2
g	0	0	0
q	2	2	2
es	0.44803335835368546		
es		10.0	
power			0.8000060699483386

```
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/td >< td >< /td >< /tr >< /tbody >< /table >
```

## CHAPTER 6

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### Credit and disclaimer

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This document is heavily built on <https://www.causalevaluation.org/uploads/7/3/3/6/73366257/powerup.xlsm>. All the design and variable explanations are from this sheet.



## CHAPTER 7

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### References

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Dong, N. & Maynard, R. A. (2013). PowerUp!: A tool for calculating minimum detectable effect sizes and minimum required sample sizes for experimental and quasi- experimental design studies, *Journal of Research on Educational Effectiveness*, 6(1), 24-67. doi: 10.1080/19345747.2012.673143. <https://www.causalevaluation.org/uploads/7/3/3/6/73366257/powerup.xlsm>

Bulus, M., Dong, N., Kelcey, B., & Spybrook, J. (2019). PowerUpR: Power Analysis Tools for Multilevel Randomized Experiments. R package version 1.0.4. <https://CRAN.R-project.org/package=PowerUpR>