Second Generation P-Values in Stata

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Outline

1. Second Generation P-Values: An Introduction
2. The SGPV-package: Commands & Examples

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- A Python implementation exists as well (but without the `sgpv`-command)
- Focus in this presentation only on SGPVs and not on their diagnostics (Power functions and False Confirmatory/Discovery Risk)

SGPV definition

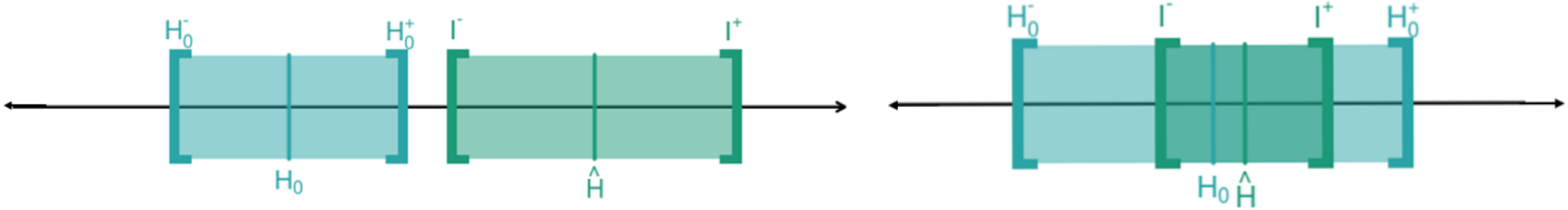
Equation 1 of Blume et al. (2019)

$$p_\delta = \frac{|I \cap H_0|}{|I|} * \max\left\{\frac{|I|}{2 * |H_0|}, 1\right\}$$

$$= \begin{cases} \frac{|I \cap H_0|}{|I|} & \text{when } |I| \leq 2|H_0| \\ \frac{1}{2}\frac{|I \cap H_0|}{|H_0|} & \text{when } |I| > 2|H_0| \end{cases}$$

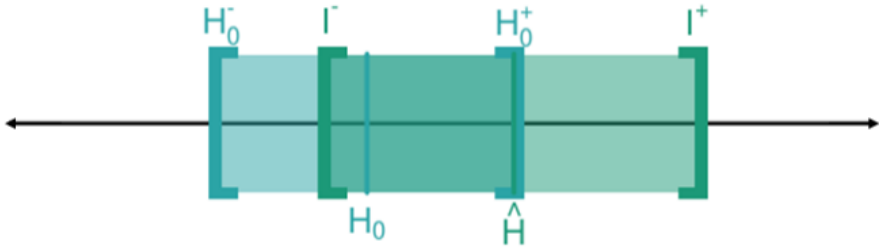
$\delta = \frac{|H_0|}{2}$,
$I = [\theta_l, \theta_u]$ the interval estimate of θ,
$|I| = \theta_u - \theta_l$ the length of the interval,
θ_u and θ_l upper and lower bound of a $100(1-\alpha)\%$ confidence interval,
H_0 an interval null hypothesis, its length $|H_0|$,
$|I \cap H_0|$ the intersection or overlap of the two intervals,
$\max\left\{\frac{|I|}{2|H_0|}, 1\right\}$ a correction term

SGPV Illustration

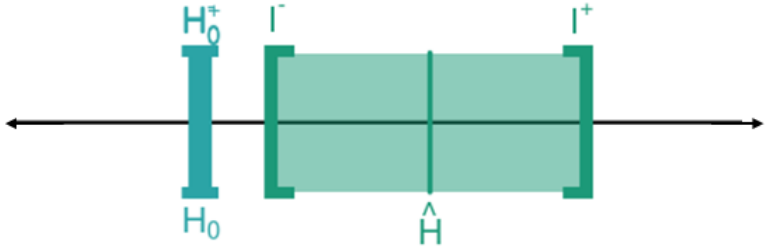


(a) $p_\delta = 0$

(b) $p_\delta = 1$



(c) $p_\delta = 0.5$



(d) Point null hypothesis

Figure: Illustration of interval and point null hypothesis, H_0; the estimated effect that is the best supported hypothesis, $\widehat{H} = \widehat{\theta}$; the 95% confidence interval (CI) for the estimated effect $\left[I^-, I^+\right]$; and the interval null hypothesis $\left[H_0^-, H_0^+\right]$.

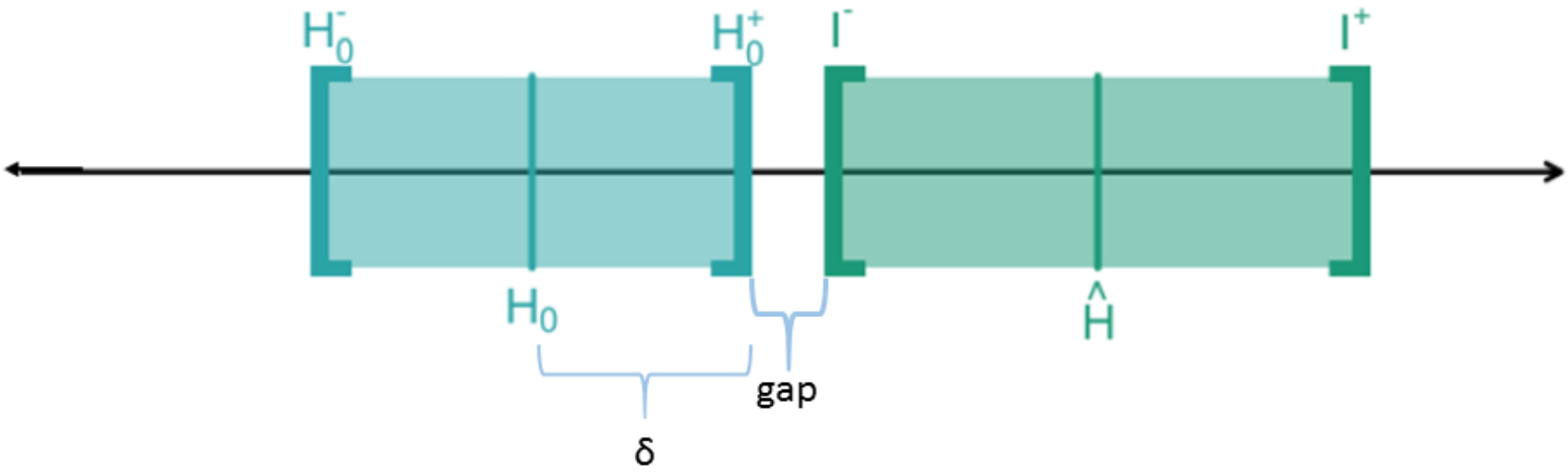
Delta-Gap: Formula and Illustration

A way of ranking two studies that both have second-generation p-values of zero ($p_\delta = 0$).

$$\text{Delta-Gap} = \frac{\text{gap}}{\delta}$$

$$\text{gap} = \max(\theta_l, H_{0l}) - \min(H_{0u}, \theta_u)$$

$$\delta = \frac{|H_0|}{2}$$



The SGPV-package

sgpv-package consists of:

- `sgpv` - a wrapper around the other commands, `sgpvalue` and `fdrisk`, to be used after estimations commands which return the matrix `r(table)`
- `sgpvalue` - calculate the SGPVs
- `sgpower` - power functions for the SGPVs
- `fdrisk` - false confirmation/discovery risks for the SGPVs
- `plotsgpv` - plot the SGPVs

sgpv command syntax

```
sgpv [subcommand] [, quietly estimate(name)
matrix(name) coefficient(string) noconstant
nulllo(string) nullhi(string)
matlistopt(string asis) bonus(string) format(%fmt)
nonullwarnings fdrisk_options permament]
[:  estimation_command]
```

sgpv command example 1

```
. sysuse auto, clear
(1978 Automobile Data)
. sgpv, bonus(all): regress price mpg weight foreign
```

(*output omitted*)

```
Comparison of ordinary P-Values and Second Generation P-Values for a point
Null-Hypothesis of 0
```

Variables	P-Value	SGPV	Delta-Gap	Fdr
mpg	.7693	.5	.	.
weight	0	0	2.2067	.0479
foreign	0	0	2300	.048
_cons	.0874	.5	.	.

```
Warning:
You used the default point 0 null-hypothesis for calculating the SGPVs.
This is allowed but you are strongly encouraged to set a more reasonable
interval null-hypothesis.
The default point 0 null-hypothesis will result in having SGPVs
of either 0 or 0.5.
```

sgpv command example 2

```
. sgpv ,coefficient(mpg weight foreign) nulllo(20 2 3000) nullhi(40 4 6000) quie
> tly: sqreg price mpg rep78 foreign weight, q(10 25 50 75 90)
```

Comparison of ordinary P-Values and Second Generation P-Values with an individual null-hypothesis for each variable

Variables	P-Value	SGPV	Null-LB	Null-UB
q10				
mpg	.1004	0	20	40
weight	.5264	.1104	2	4
foreign	.3541	.0467	3000	6000
q25				
mpg	.9415	.5	20	40
weight	.1265	.4369	2	4
foreign	.2717	.2609	3000	6000
q50				
mpg	.9246	.5	20	40
weight	.0212	.5	2	4
foreign	.03	.5189	3000	6000
q75				
mpg	.7024	.5	20	40
weight	.156	.5	2	4
foreign	.2137	.5	3000	6000
q90				
mpg	.9113	.5	20	40
weight	.0703	.5	2	4
foreign	.226	.4998	3000	6000

sgpvalue command syntax

```
sgpvalue, estlo(string) esthi(string) nulllo(string)
nullhi(string) [nowarnings infcorrection(real 1e-5)
nodeltagap nomata noshow replace]
```

sgpvalue command

```
. local lb log(1.05) log(1.3) log(0.97)
. local ub log(1.8) log(1.8) log(1.02)
. sgpvalue , estlo(`lb´) esthi(`ub´) nulllo(log(1/1.1)) nullhi(log(1.1))
Second Generation P-Values
     SGPV  Delta-Gap
------------------------
 .1220227           .
        0    1.752741
        1           .
```

Final remarks

- SGPVs are easy to understand and to use.
- Setting an interval null-hypothesis instead of a point null-hypothesis does not hurt.
- sgpv-package offers an easy way to integrate SGPVs into the standard workflow.

References

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