What can we expect from "Distributions for parameters"?

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Statistical Sciences
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Rutgers: BFF

www.utstat.toronto.edu/dfraser/documents/BFF2016

some references: /xxxx.pdf

Preamble

Distributions for parameters ?

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Around for a <u>long</u> time 1763 +

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Do they (the Distributions) do as they say ?

Preamble

<u>Distributions</u> for parameters ?

Around for a <u>long</u> time 1763 +

Vicious disagreements 1935 +

Inate ? Predator & Prey

Do they (the Distributions) do as they say ?

Or... Is there misrepresentation ?

1 p-values recently

2 What is a p-value?

3 Does $p(\theta)$ give a distribution for θ? Reproducibility?

4 A Proposed Distribution for θ? Evaluate it!

5 A simple example: Linearity and Reproducibility

6 The simple example: Curvature and Irreproducibility

7 p-value vs. Integrated posterior

8 Marginalization and Inversion

9 Discussion

1 p-values recently

Everywhere Science science journals even some saying "No p-values"

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ASA Blue ribbon committee: 25 statistical leaders

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- Full info & transparency

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- Be good!

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$= F(y^0; \theta)$

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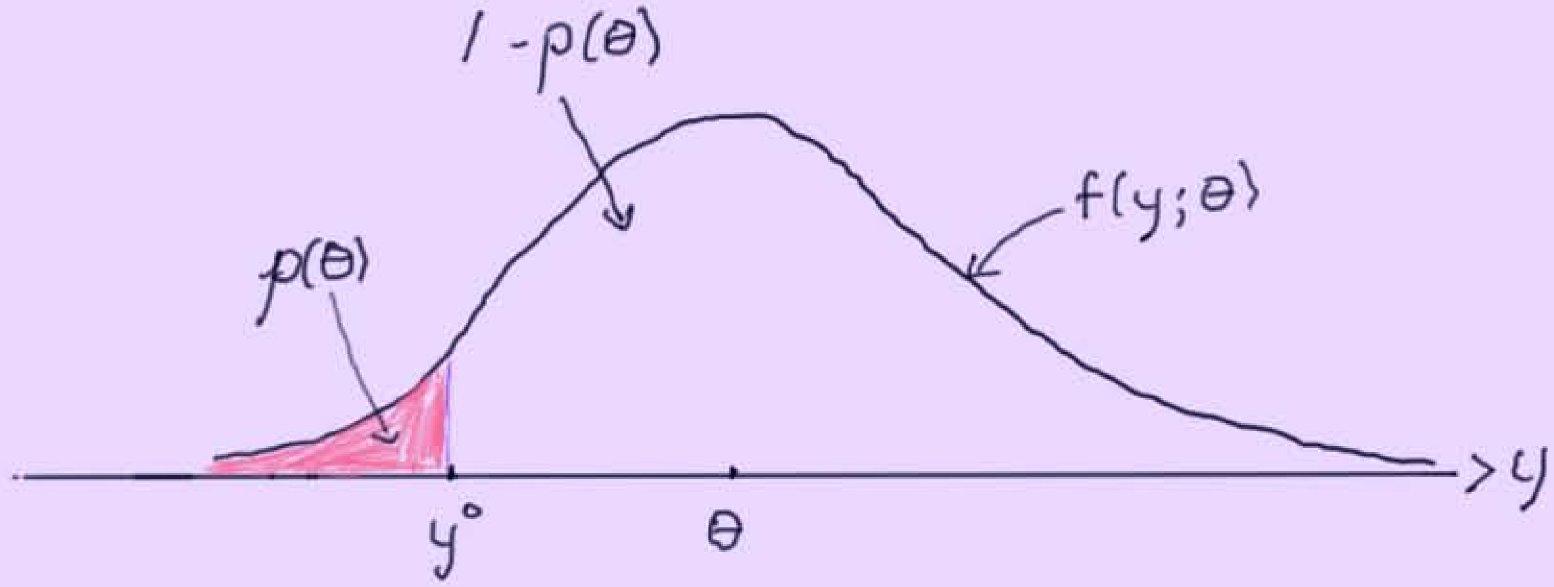

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$p(\theta)$ = Where y° is with respect to θ in statistical units

$= F(y^\circ; \theta)$

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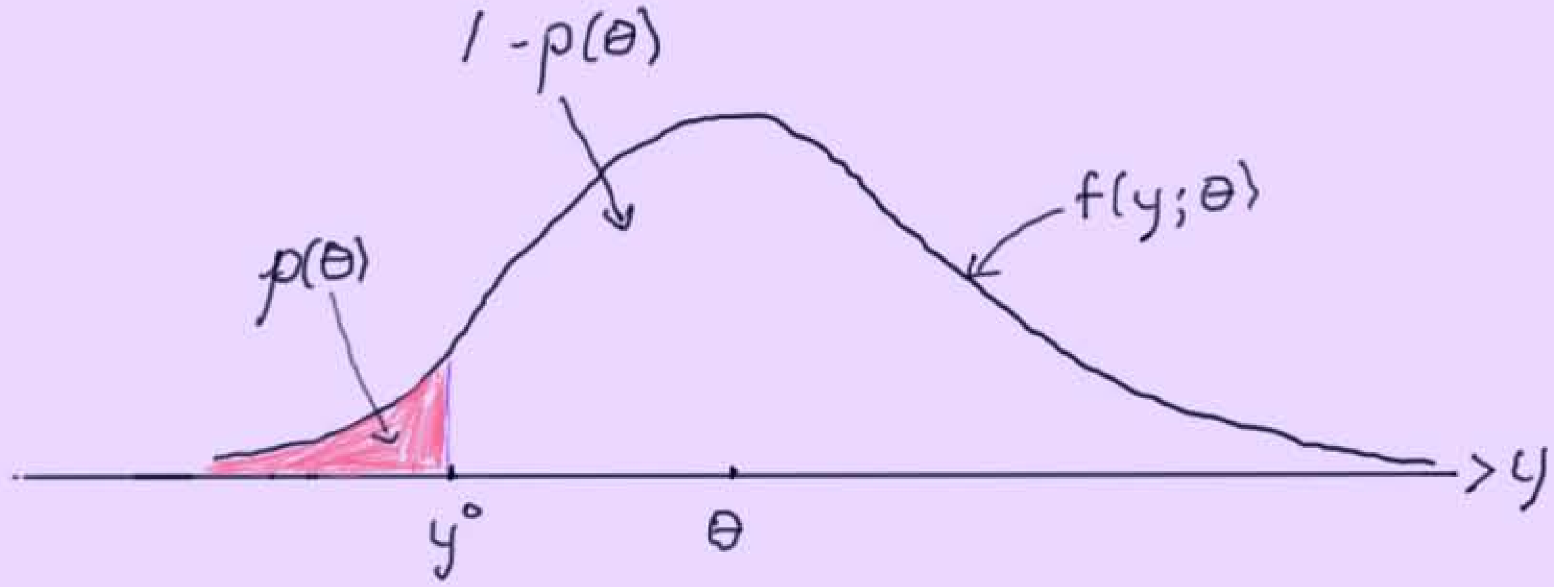

$p(\theta)$ = Statistical position of y° re θ

Forget: left tail; right tail; two sided; and other pacifiers

Leave to user/scientist... in context 1 in 20, 1 in 3·5 million

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Check it out!

Get β-quantile of $p(\theta : y^0)$, say $p(\hat{\theta}_\beta(y^0) < \theta ; y^0) = \beta$

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$P\{\hat{\theta}_\beta(y) < \theta ; \theta\} = \beta$?

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$\Rightarrow$ Full Reproducibility

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- Get marginal right tail df for $\psi(\theta)$

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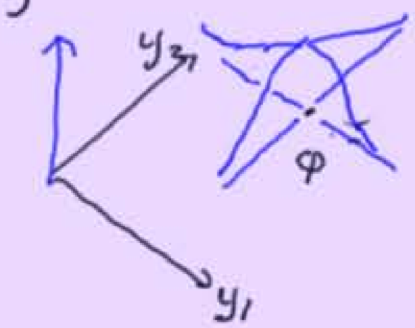
- Get marginal right tail df for $\psi(\theta)$
- Calculate corresponding quantile $\tilde{\psi}_\beta = \tilde{\psi}_\beta(y)$
- Does it "<u>behave</u>" as a quantile?
- Is $P\{\tilde{\psi}_\beta < \psi(\theta); \theta\}$ equal to β?

5 The simple example : Curvature and Irreproducibility



Model $\quad \underset{\sim}{y} \sim N\left\{ \begin{pmatrix} \varphi_1 \\ \varphi_2 \end{pmatrix} \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \right\}$ $\qquad$ Data $\begin{pmatrix} y_1 \\ y_2 \end{pmatrix}$

Interest $\quad \psi(\varphi) = \varphi_1 + \frac{\gamma}{2}\varphi_2^2$ $\qquad$ Nonlinear curved

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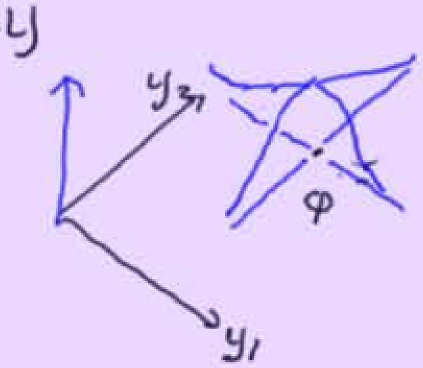

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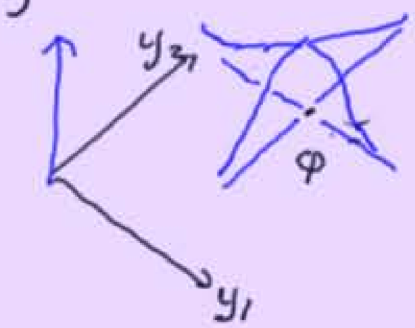

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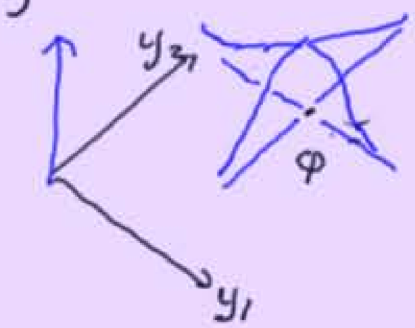

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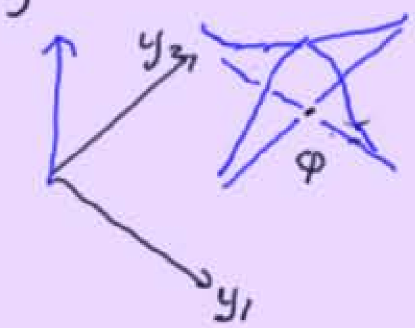

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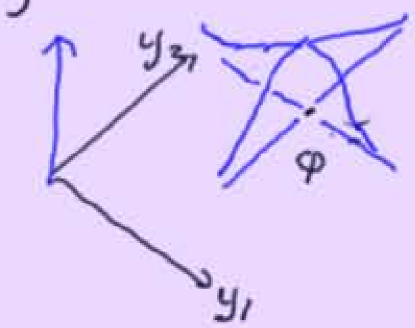

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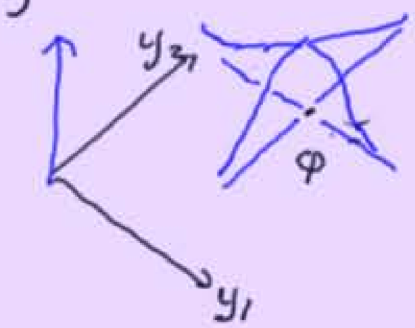

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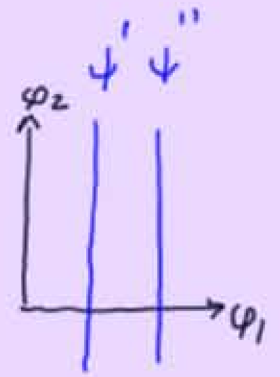
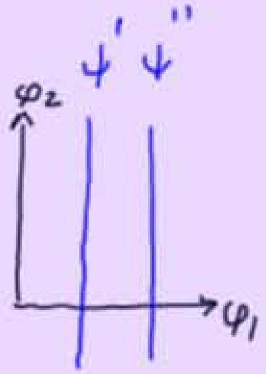
Try it out a few times ... say $N = 10{,}000$



Case ψ linear $\gamma = 0$



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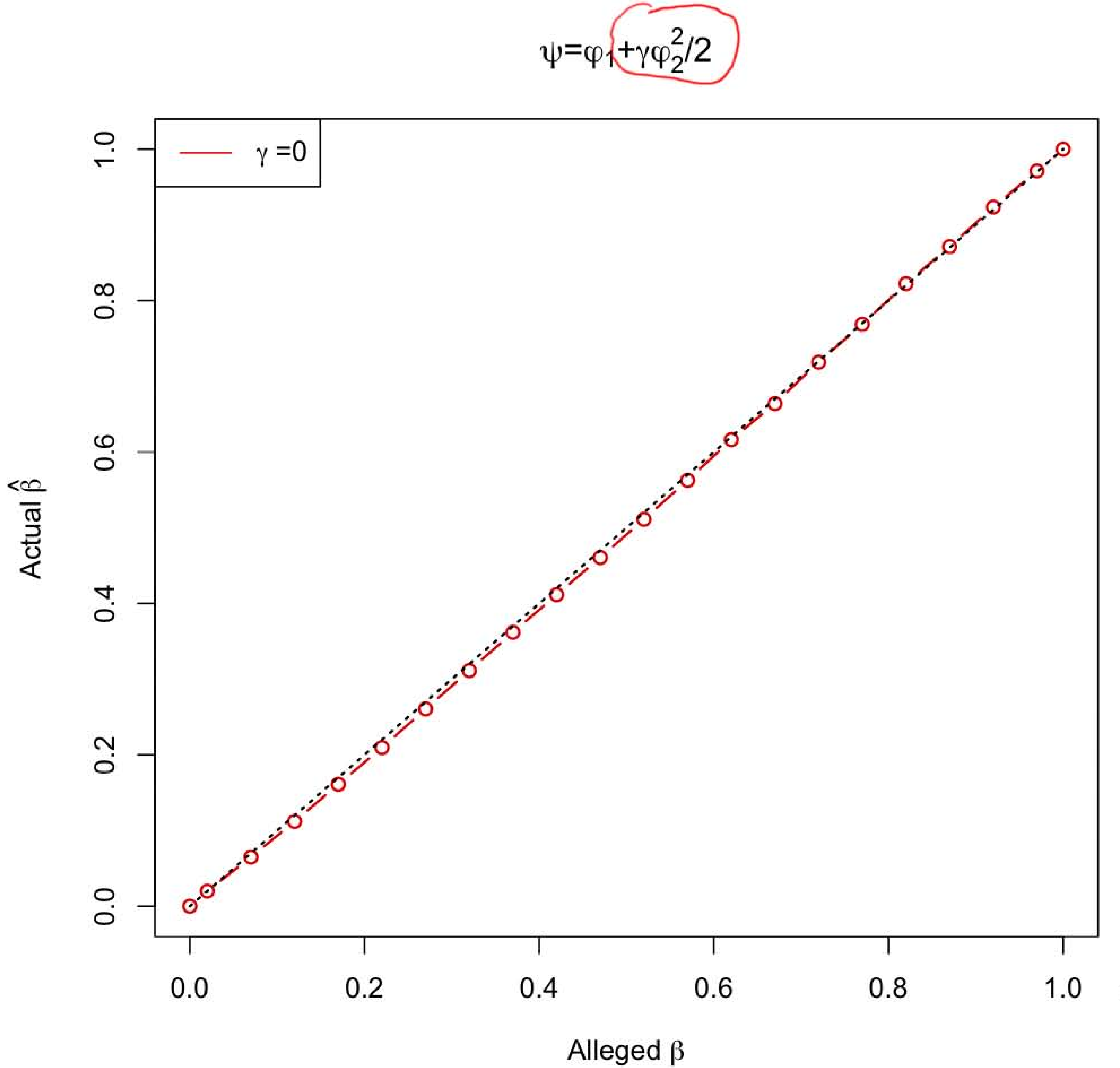

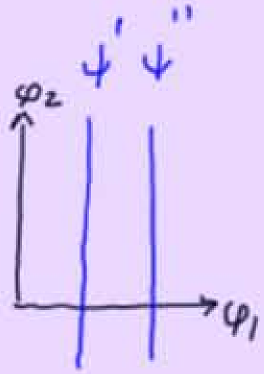

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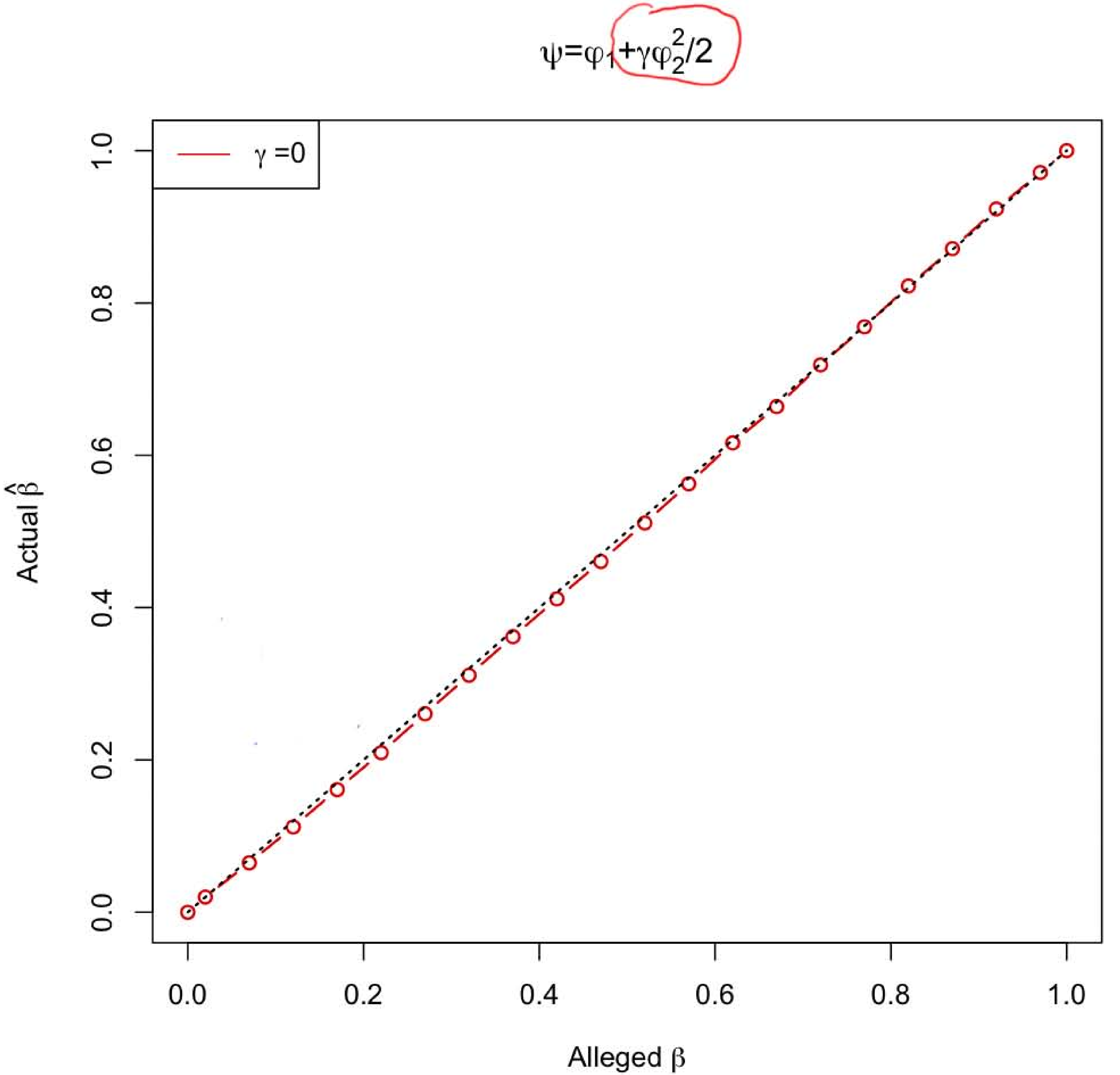
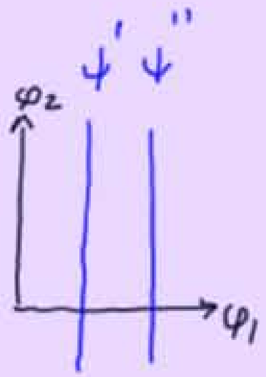
p-p looks pretty good





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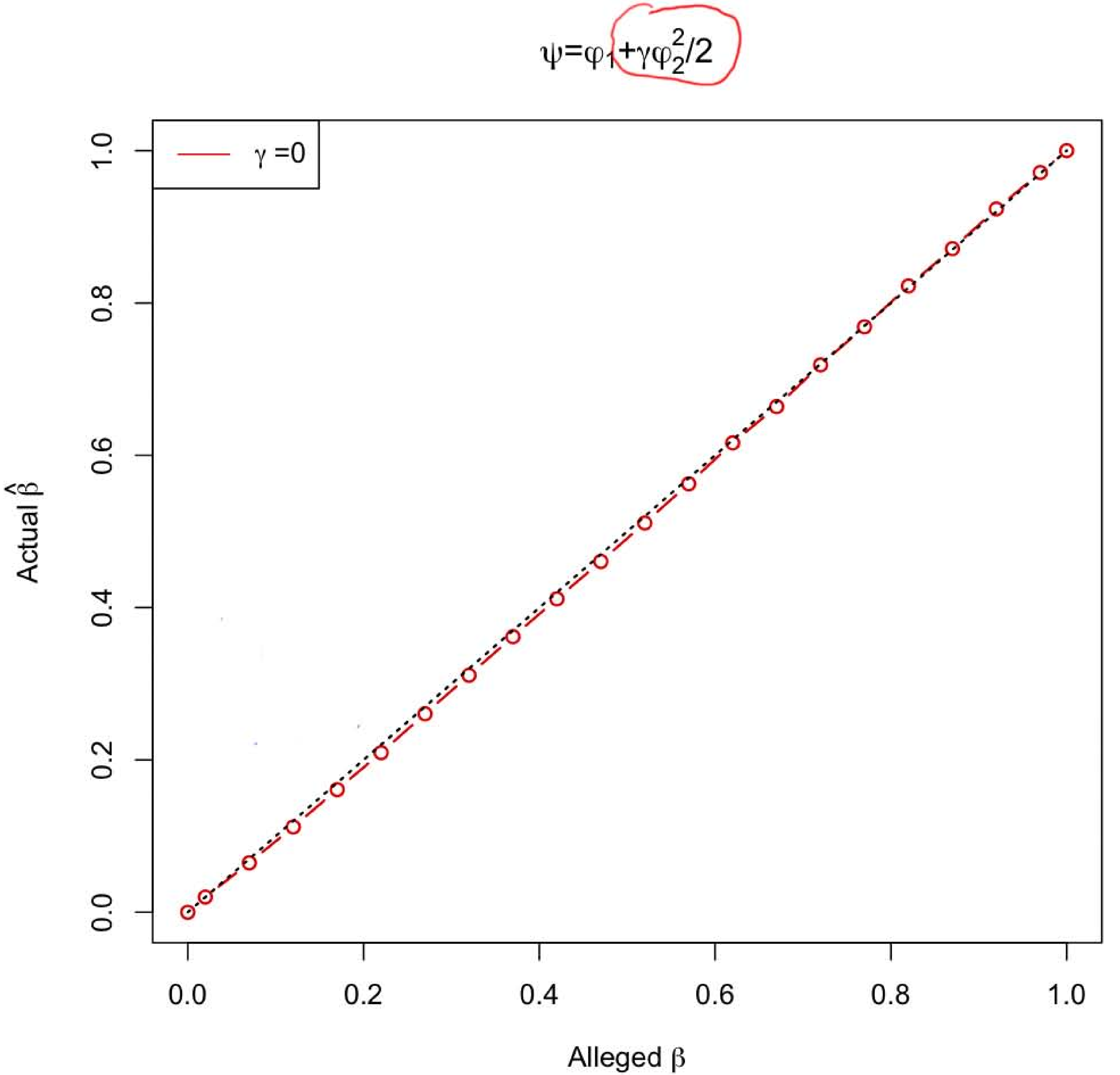

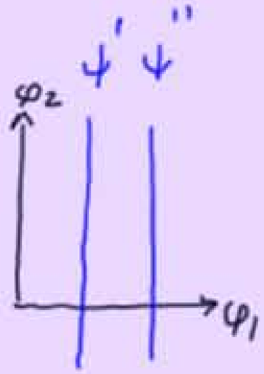

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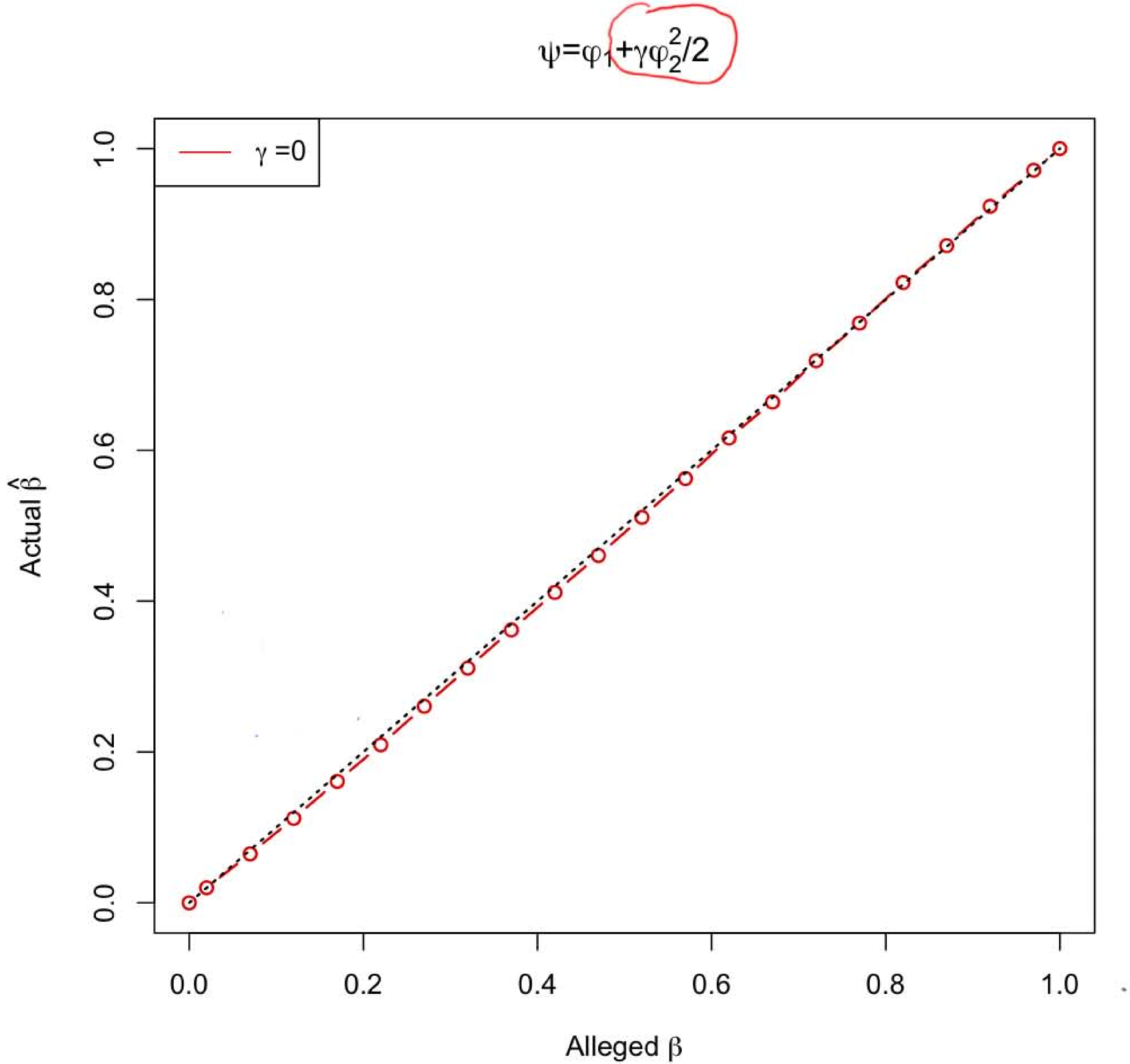
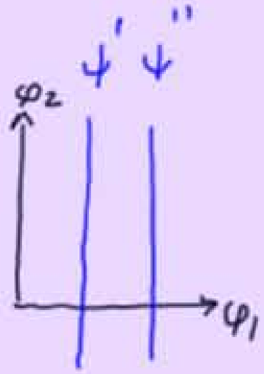
but
Dawid Stone Zidek 1973





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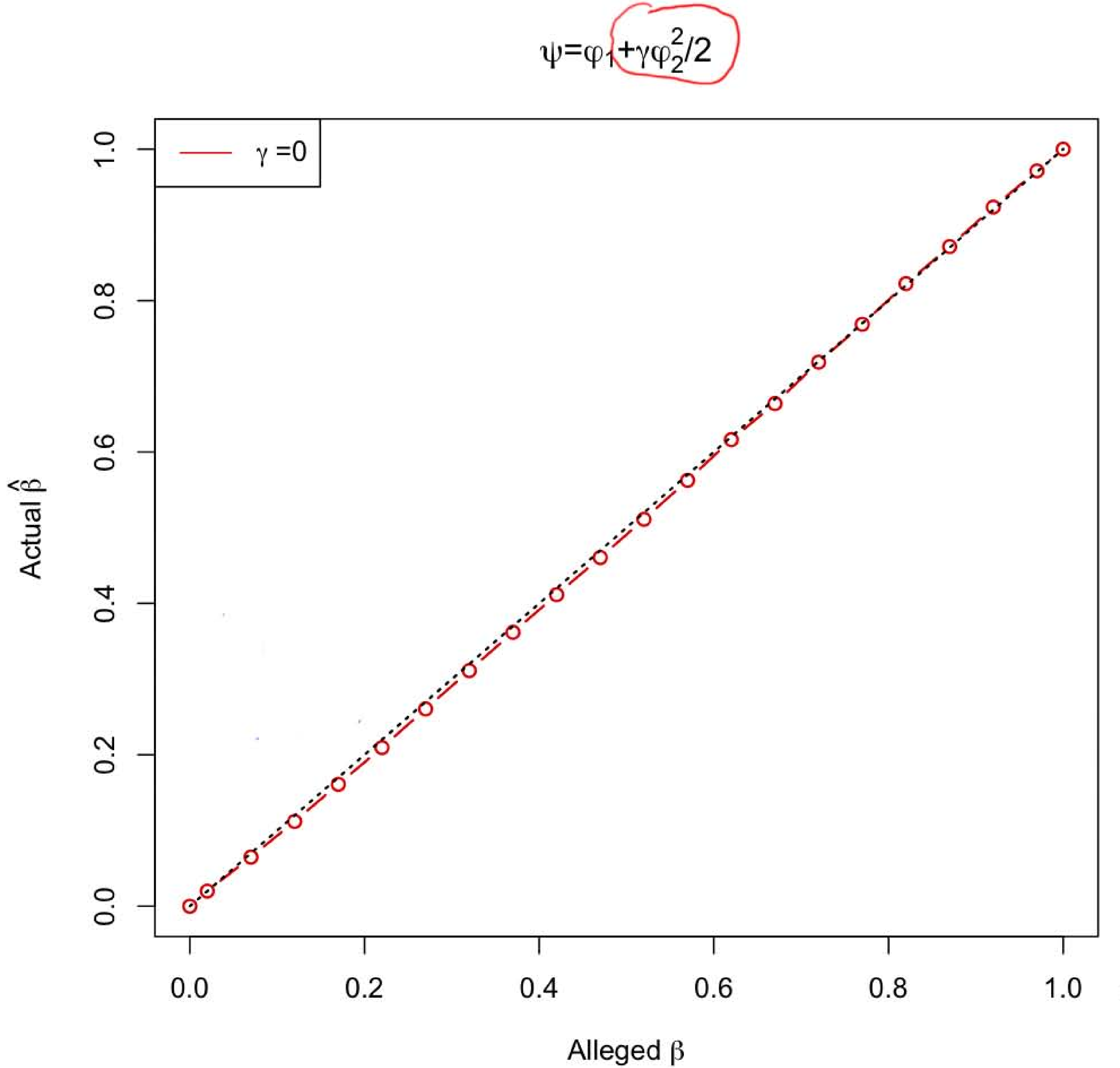
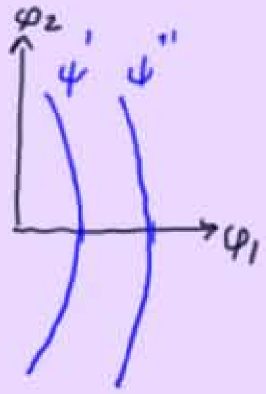
but curvature ?

Fraser 2011 247.pdf
258.pdf



6 Curved parameter



Try $\gamma = 1$

$\psi = \varphi_1 + \frac{1}{2}\varphi_2^2$

Curved interest

$N = 10,000$

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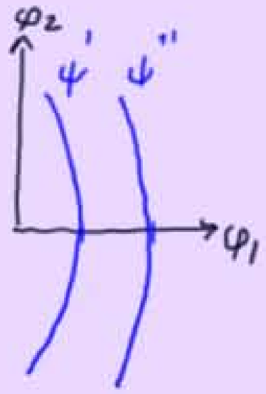

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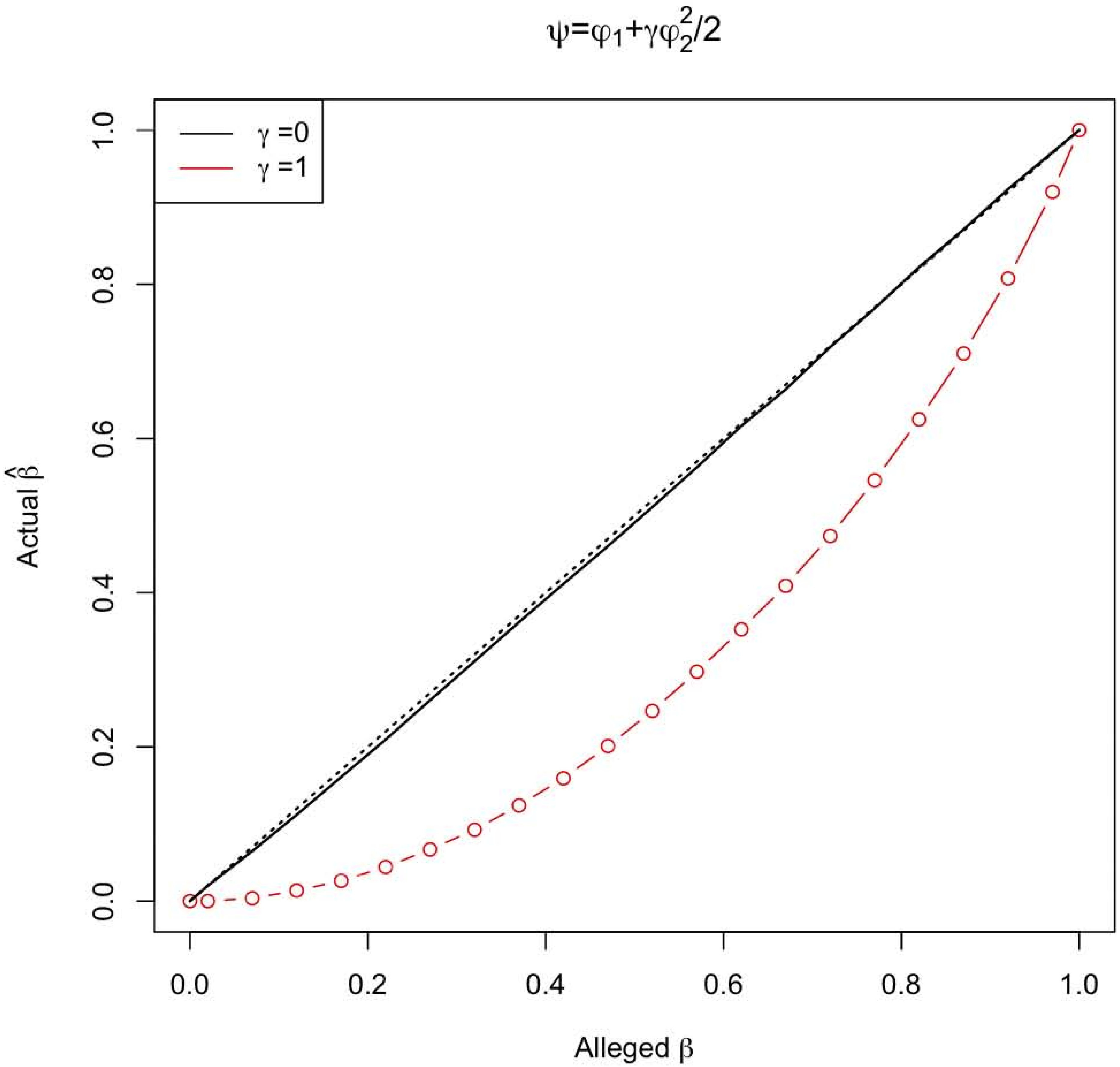

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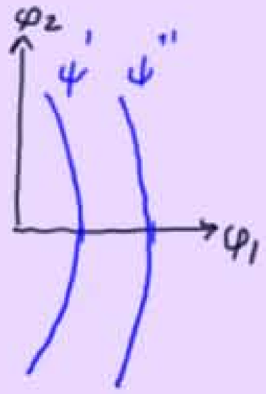

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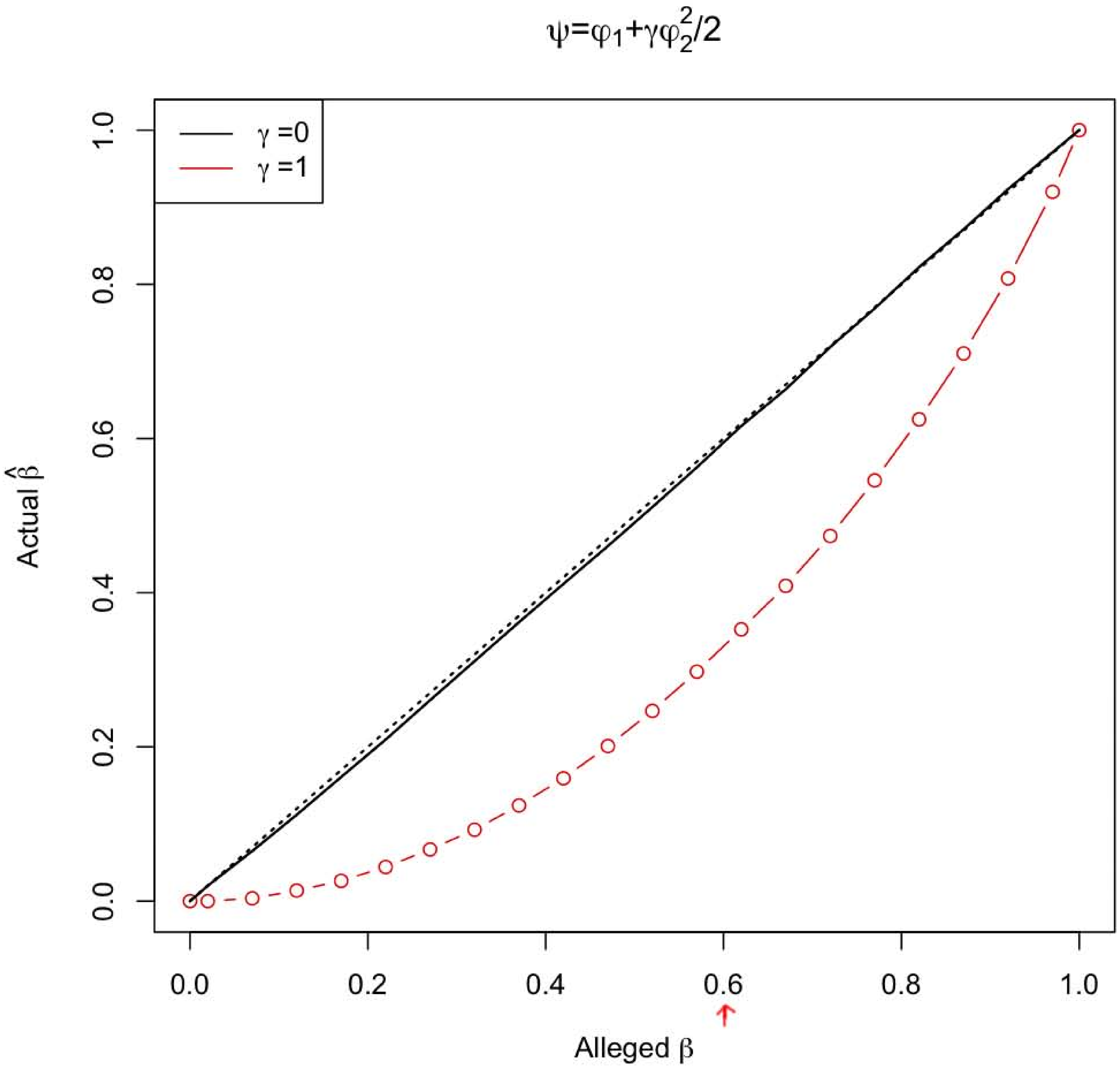
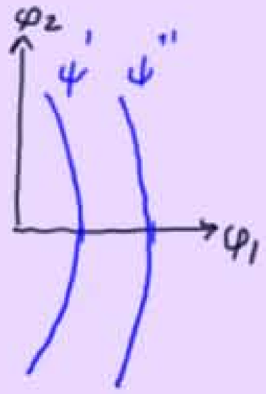
Choose 60% Conf. lower bd



6 Curved parameter



Try $\gamma = 1$

$\psi = \varphi_1 + \frac{1}{2}\varphi_2^2$

Curved interest

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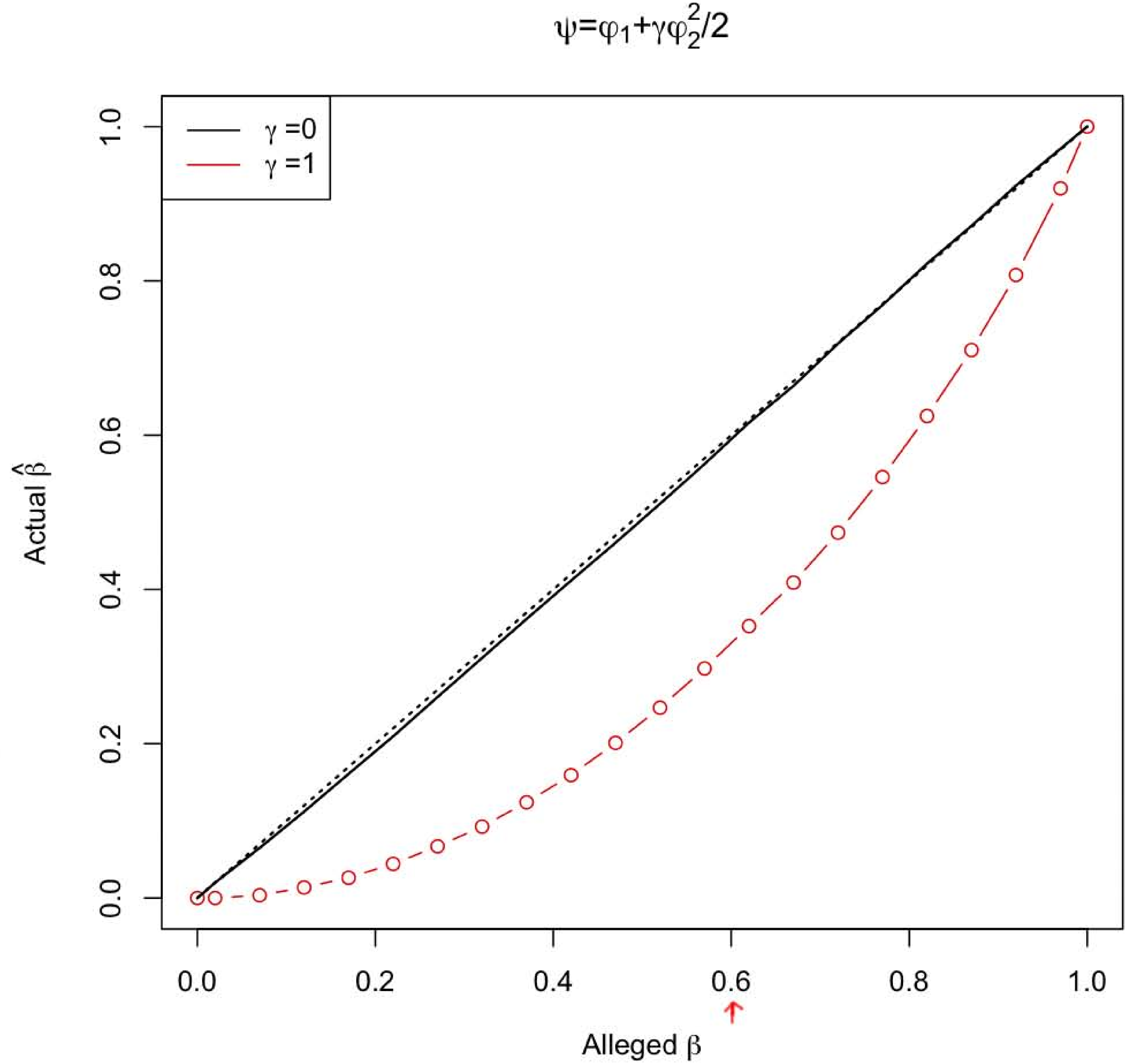
Looks like actual is 30%



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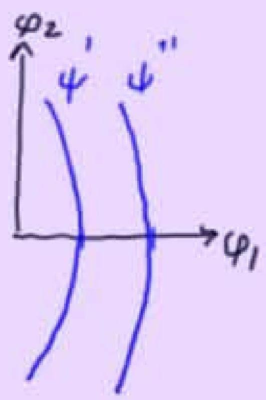

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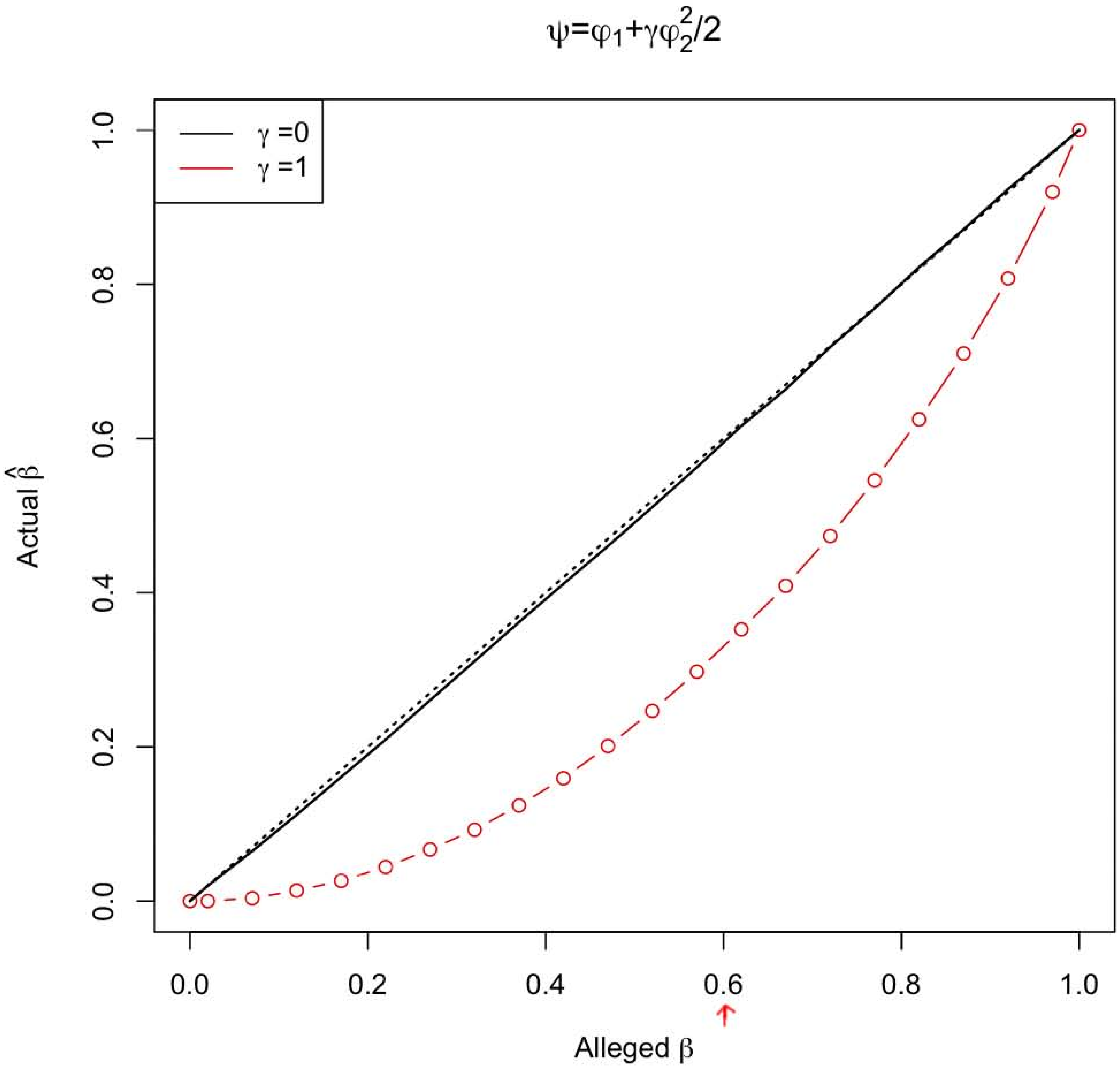

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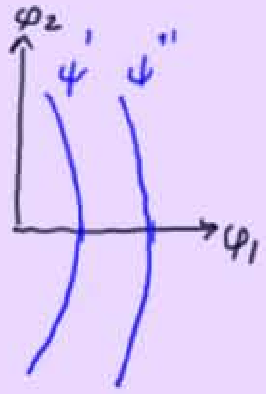

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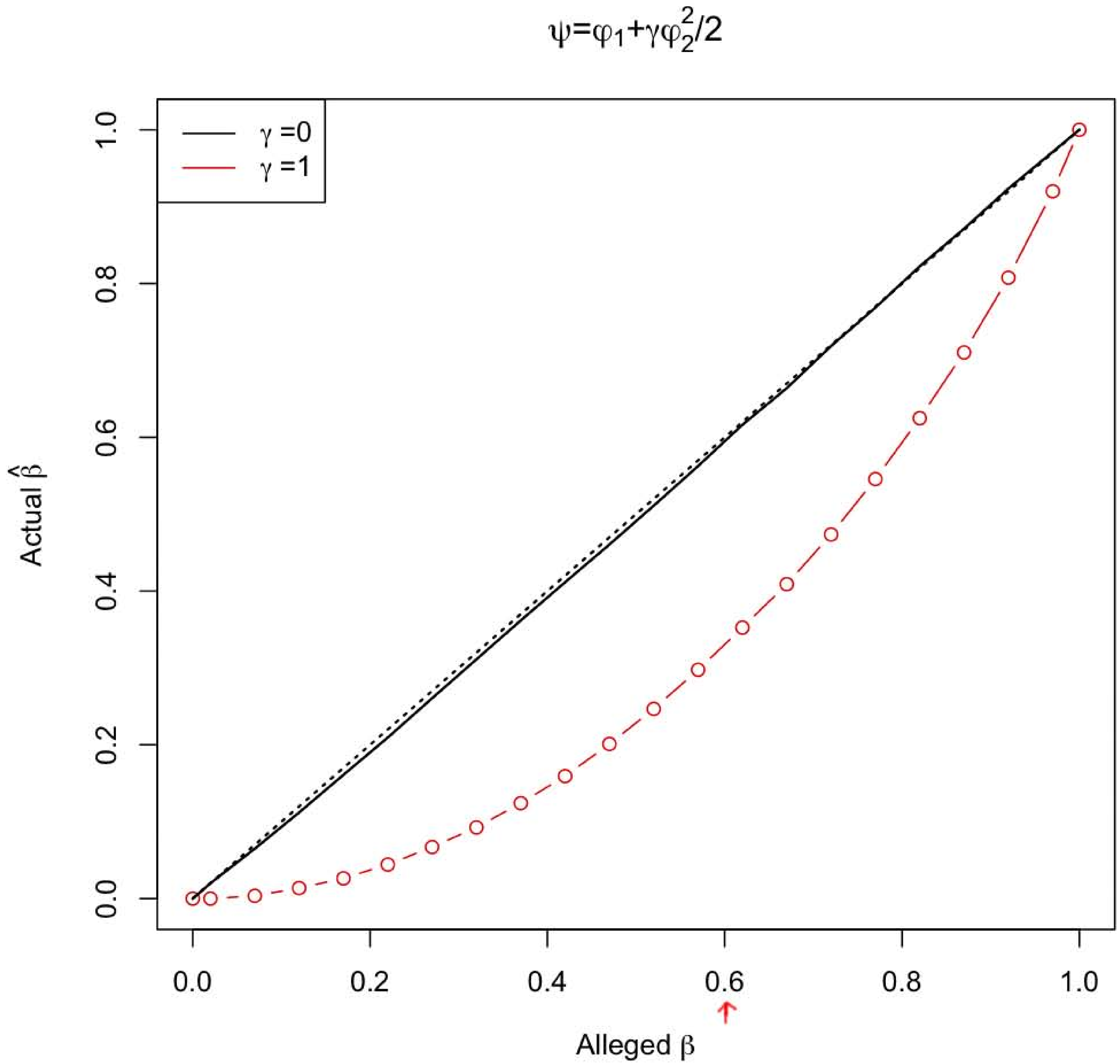

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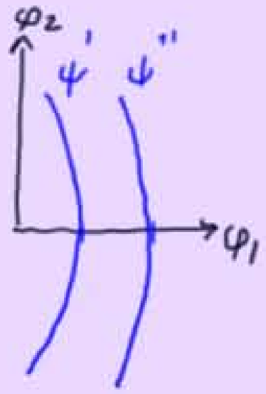

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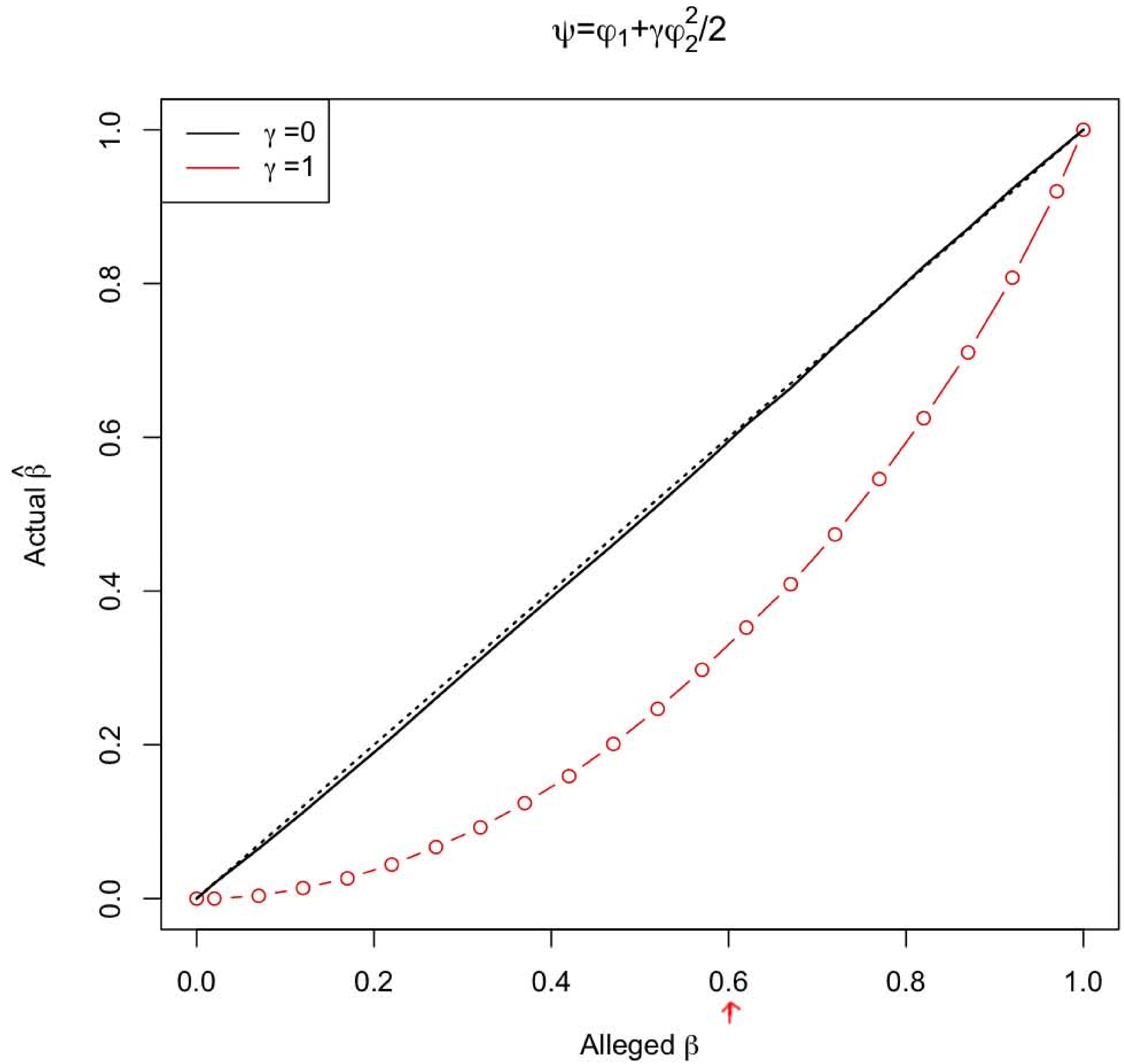
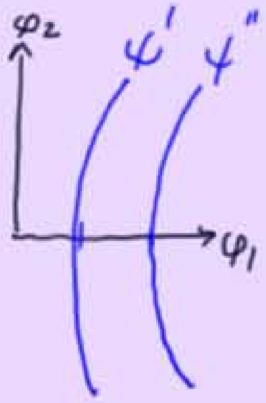


and if you had to defend your results in court ?



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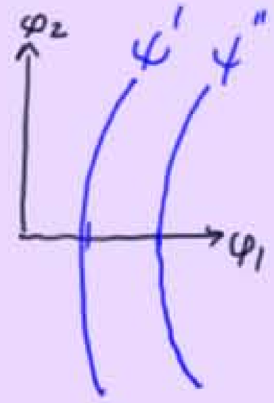
$$\psi = \varphi_1 - \frac{1}{2}\varphi_2^2$$

Opposite curvature



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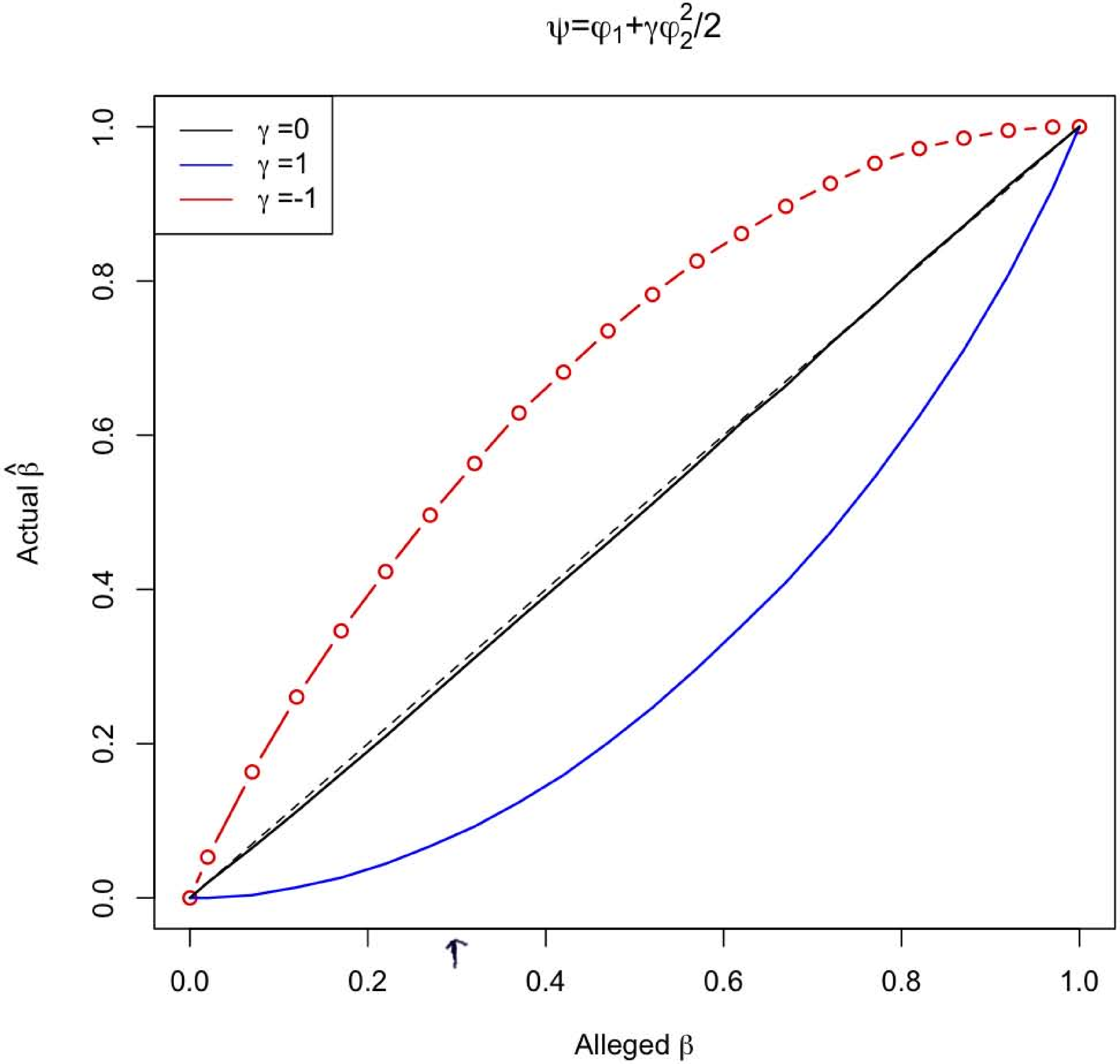

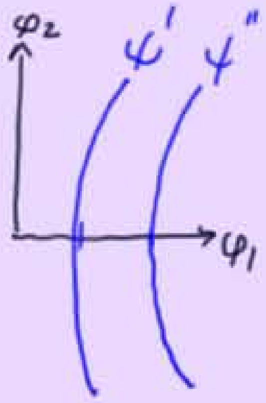

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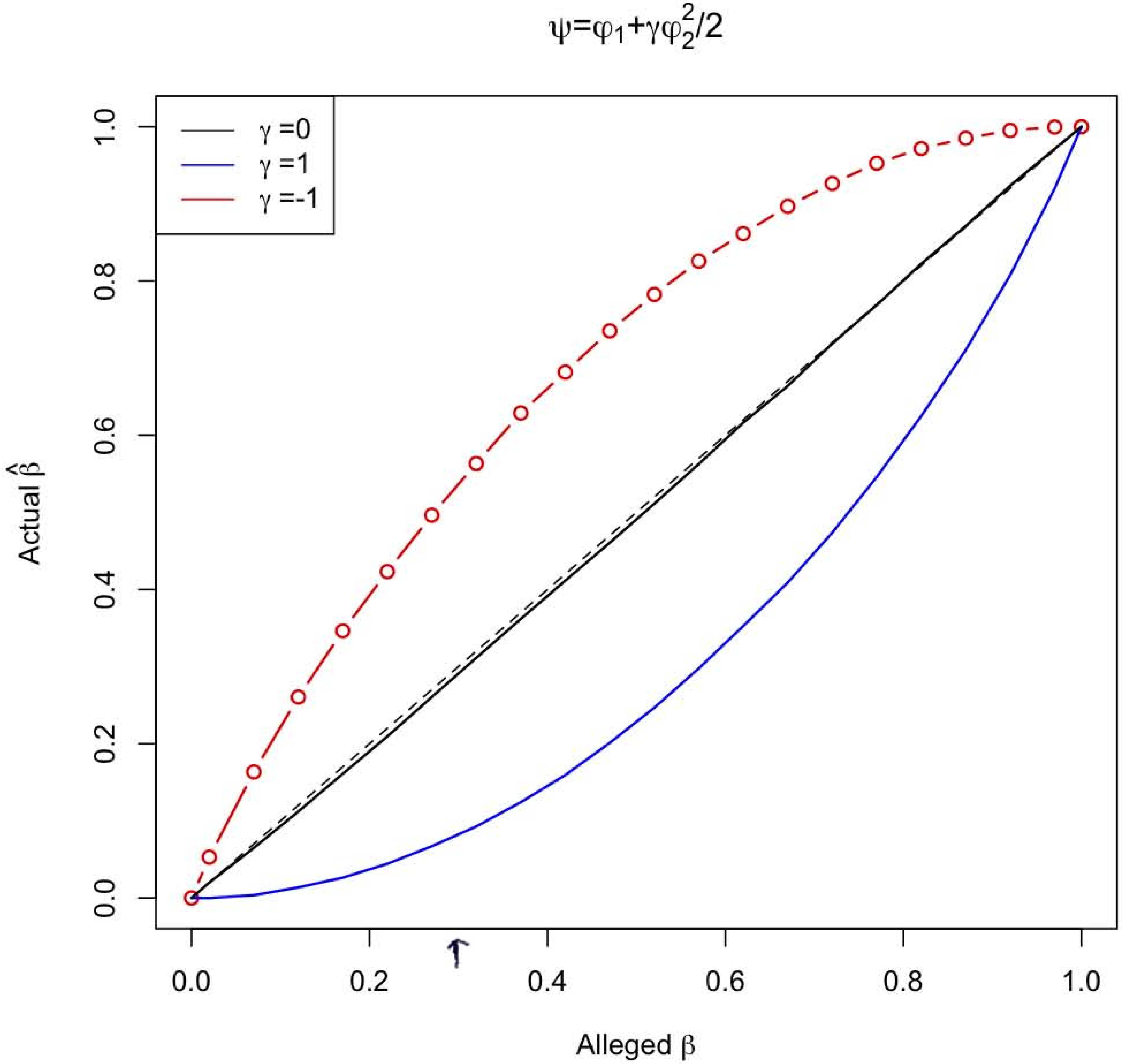

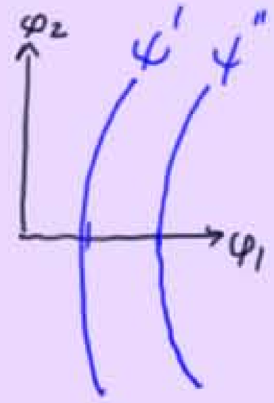

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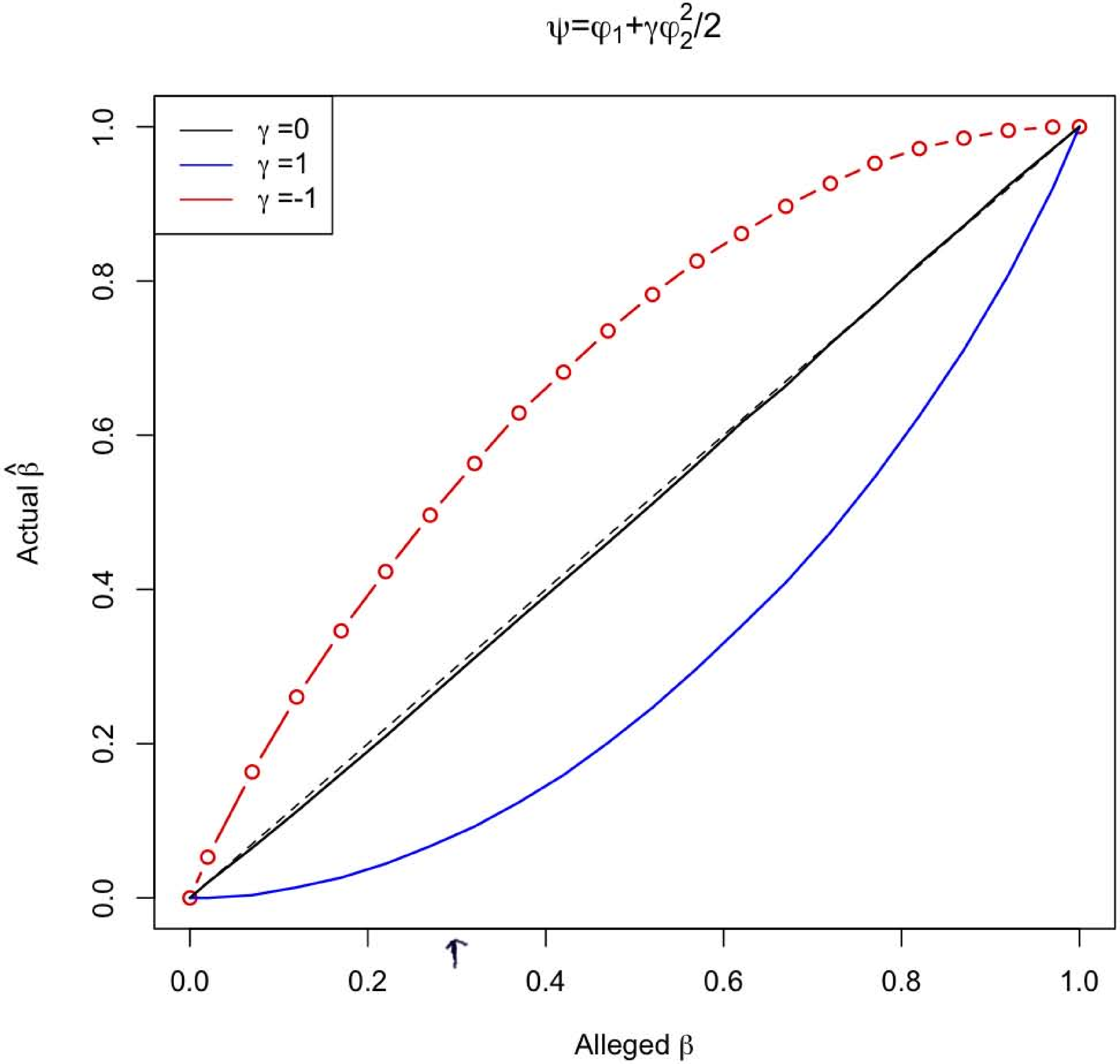
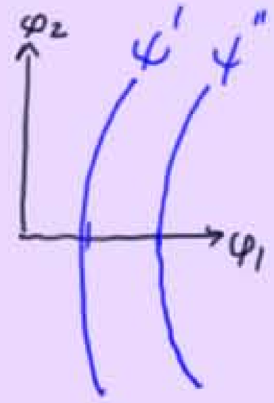
Looks like 50° repeat coverage





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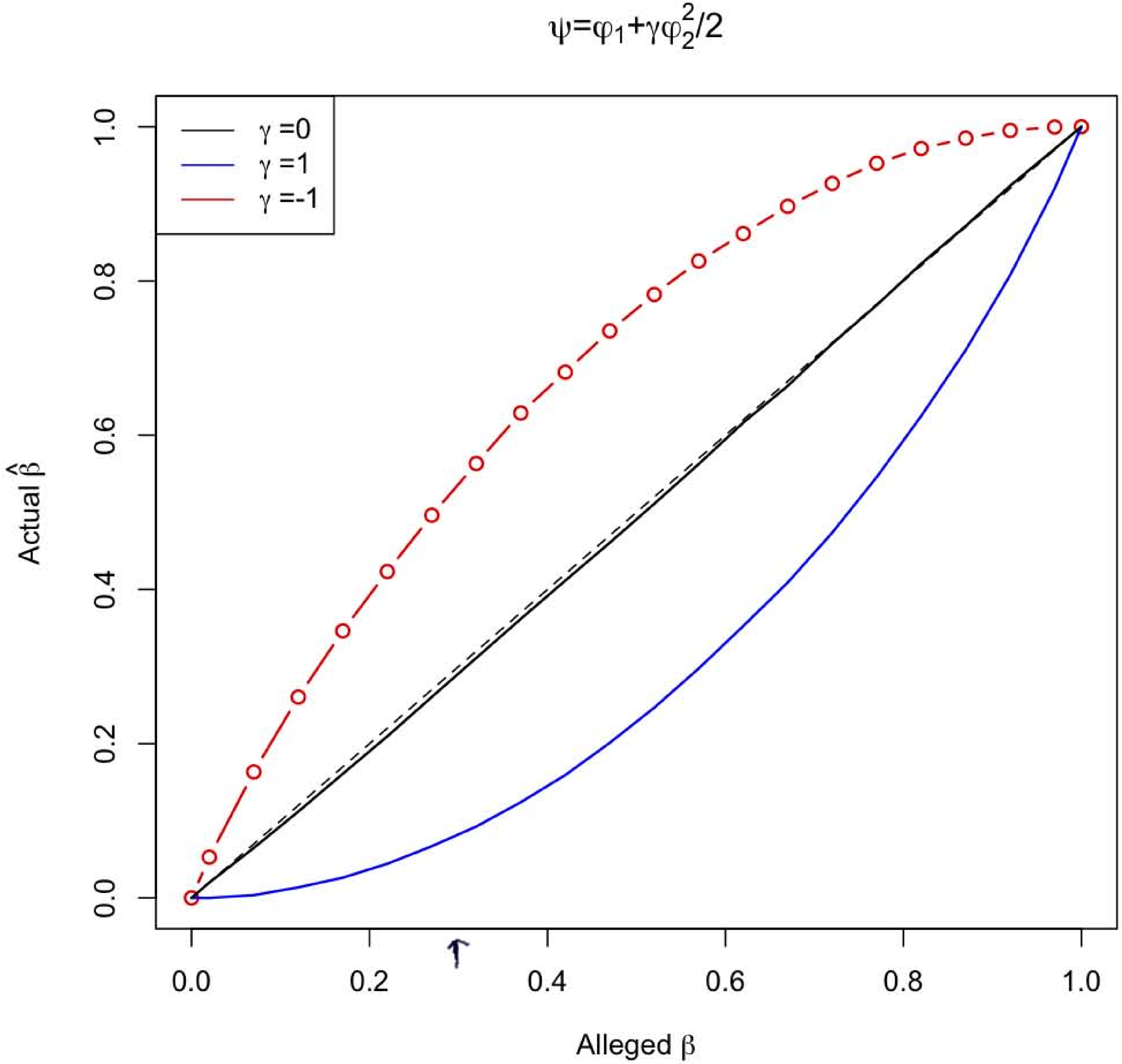
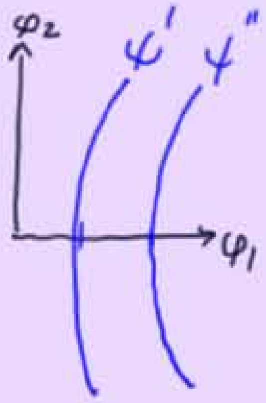
Irrep.... !





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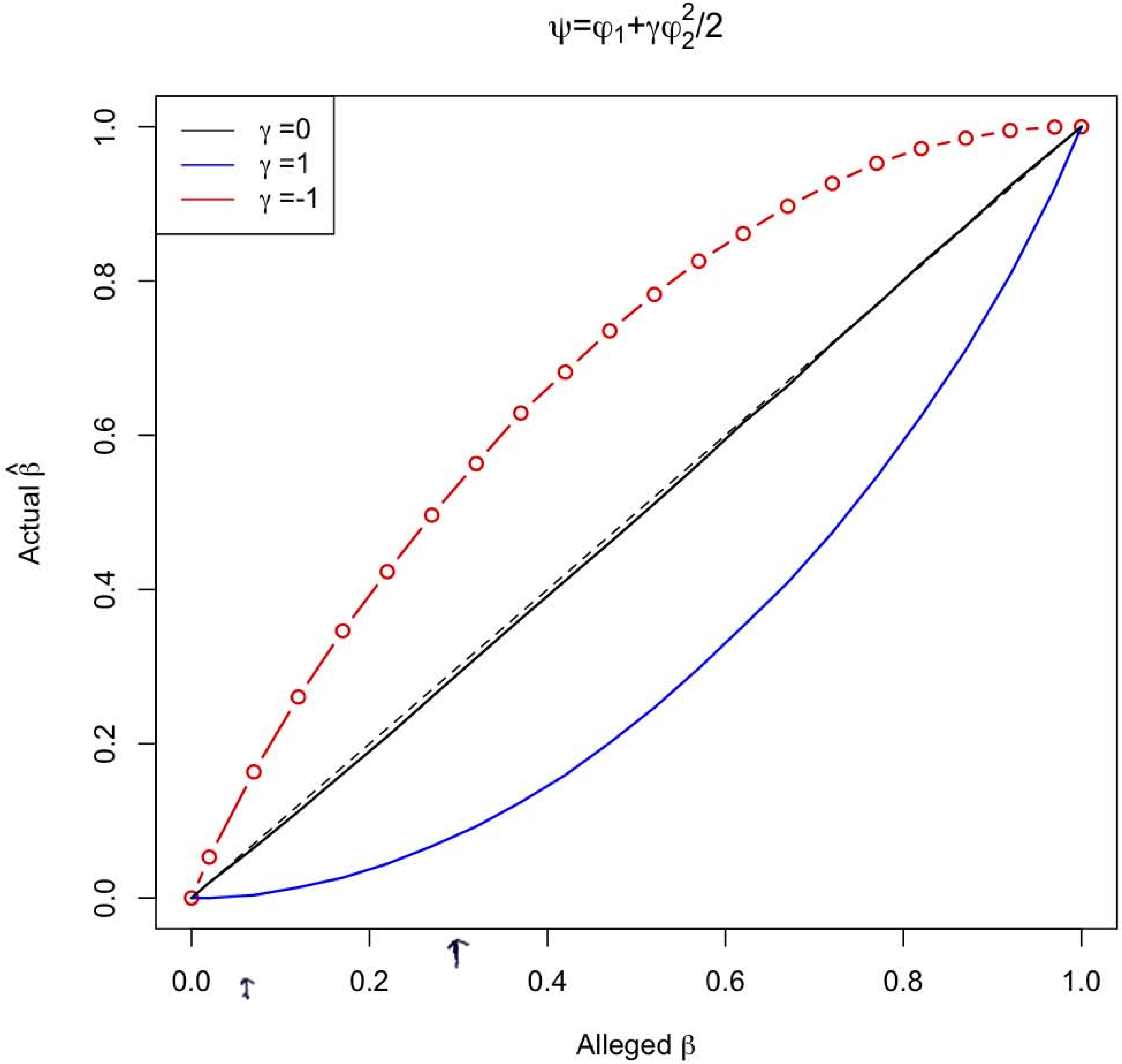

and 5% is close to 17% ?

7 p-value function

vs

Integrated confidence

Data y^0

Curved $\varphi = \varphi_1 + \gamma \varphi_2^2/2$

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Simulation $N = 10{,}000$

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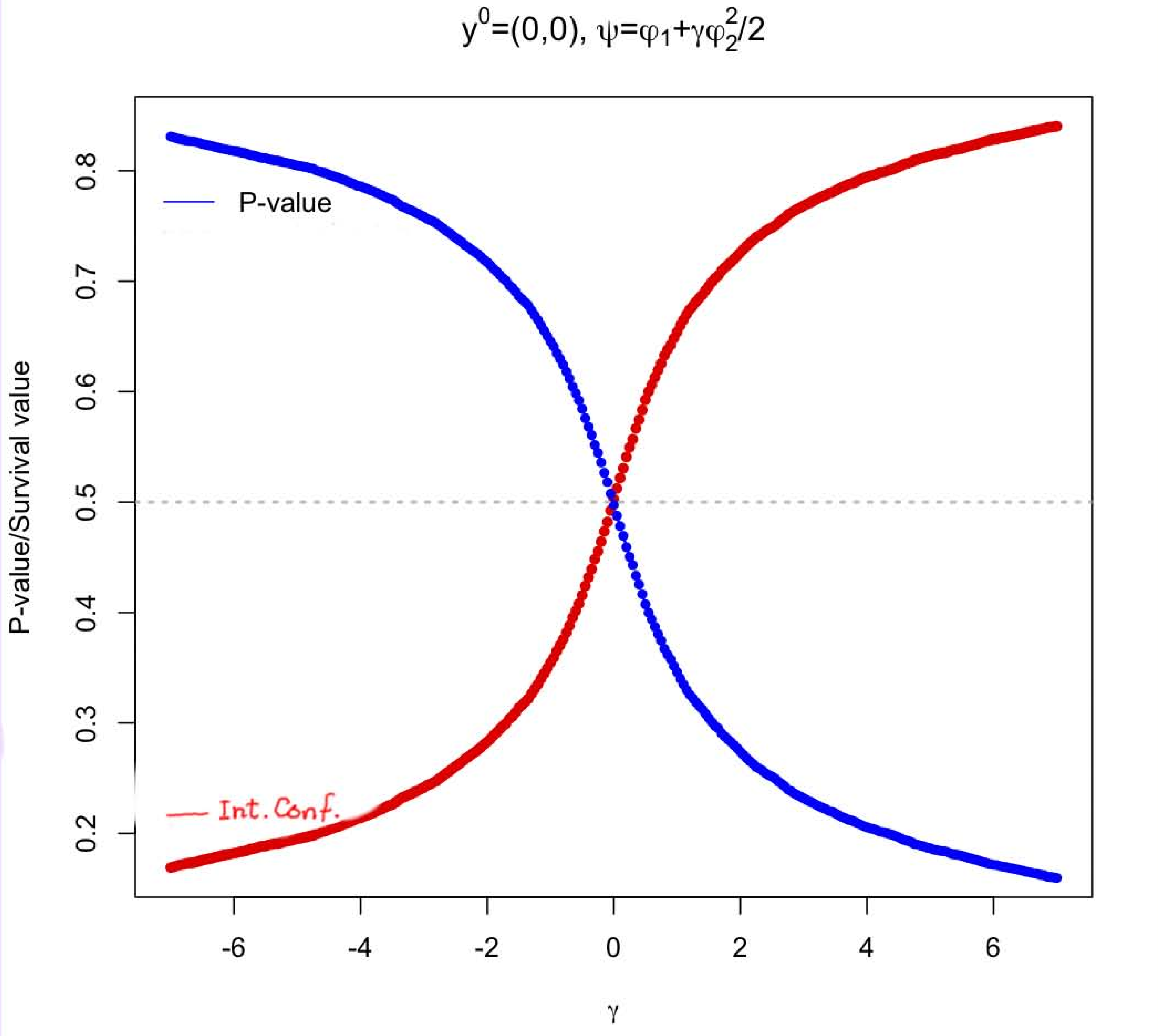

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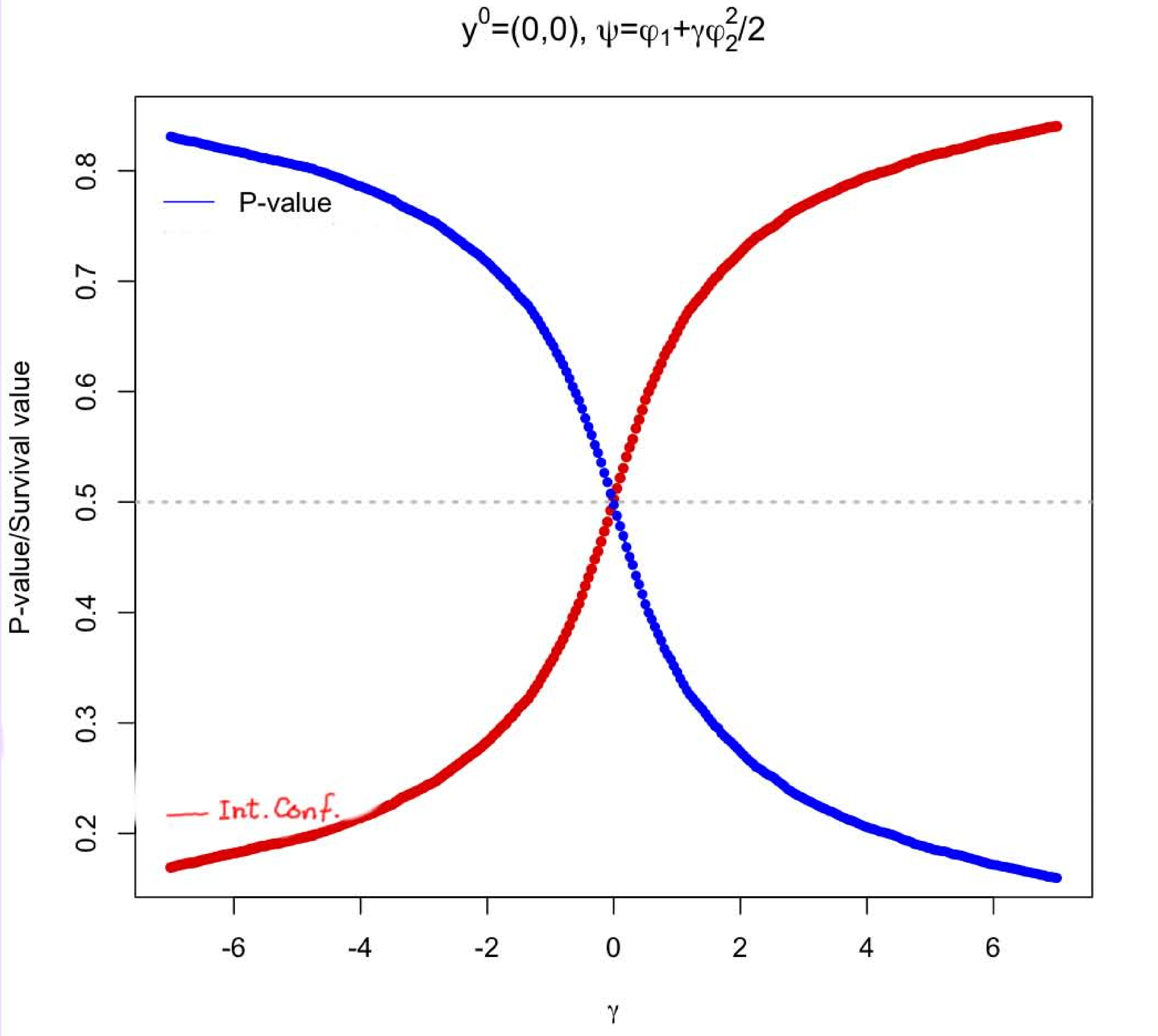

p-value function gives confidence intervals, is reproducible

7 p-value function vs Integrated confidence

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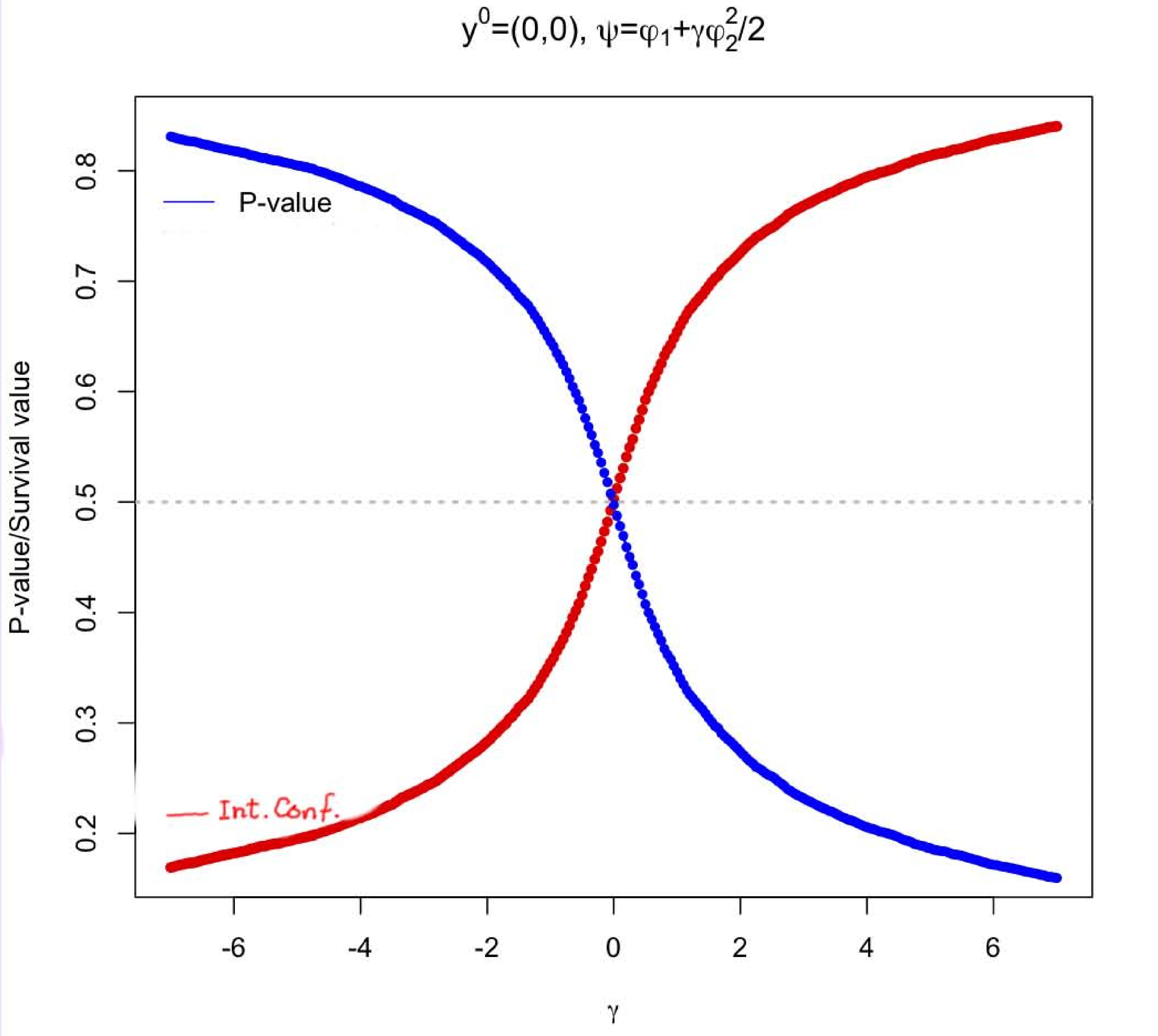
Curved $\psi = \varphi_1 + \gamma \varphi_2^2/2$

Vary curvature γ

Simulation $N = 10{,}000$



p-value function gives confidence intervals, is reproducible

Integrated confidence distribution does NOT give confidence intervals

changes wrong direction

8 Marginalization and Inversion

Marginalize ... to be relevent to interest parameter

Invert ... from pivot to parameter

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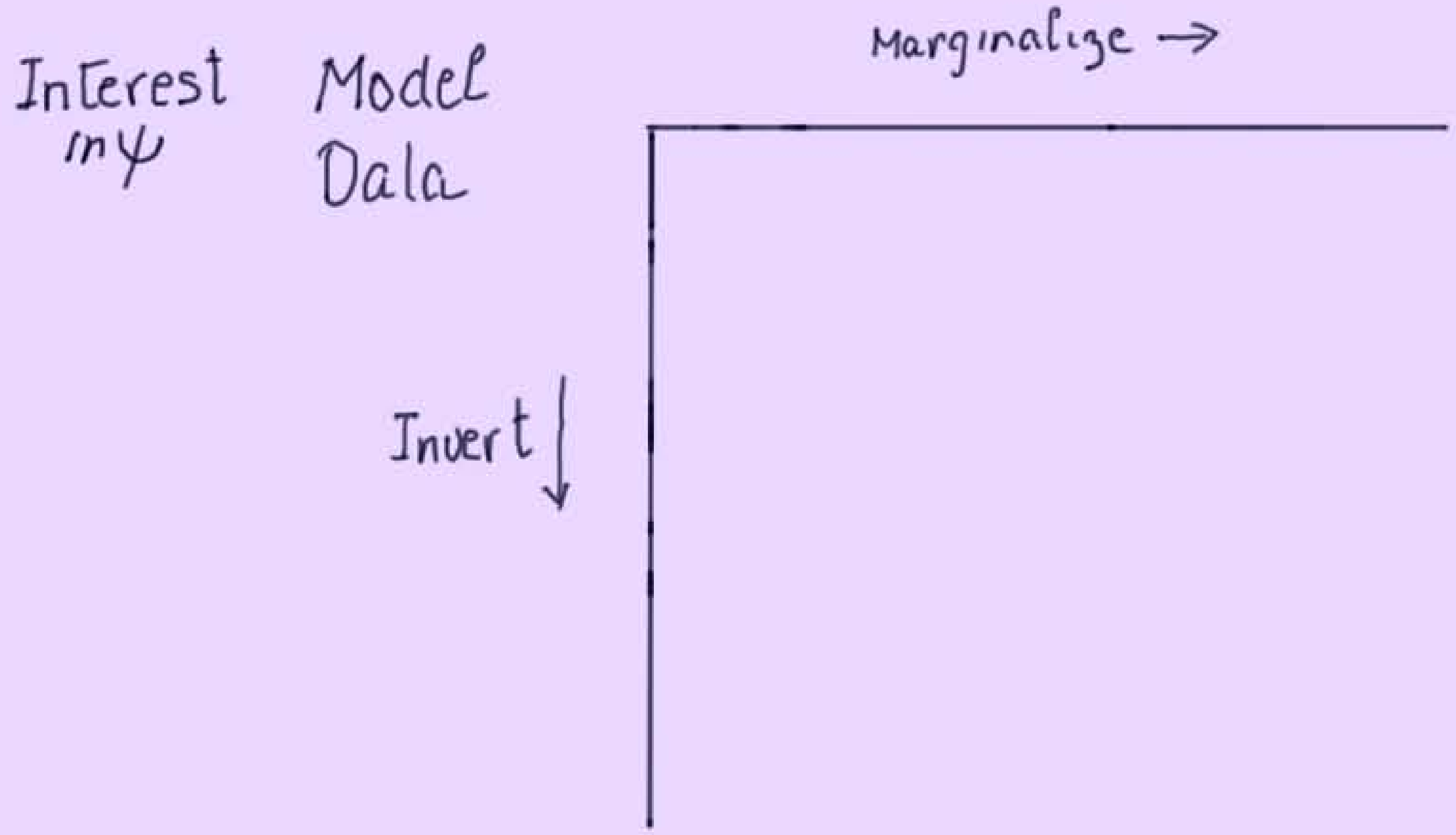

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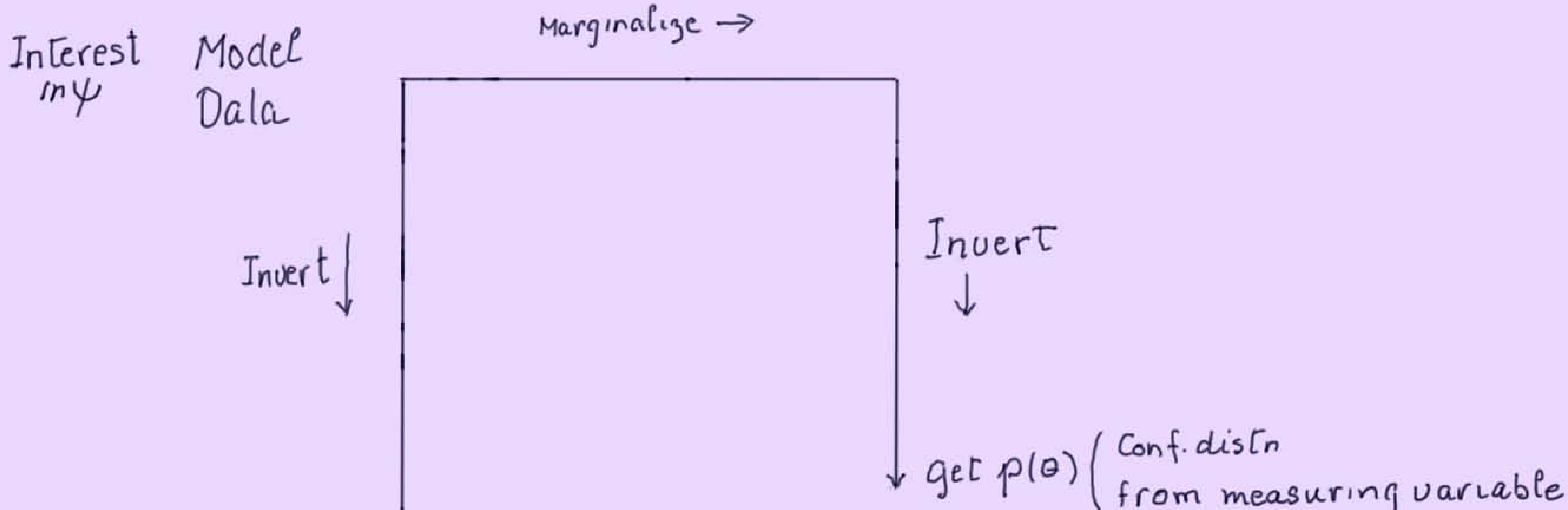

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Interest in ψ

$$
\begin{tikzcd}
\text{Model Data} \arrow[r, "\text{Marginalize}"] \arrow[d, "\text{Invert}"'] & {} \arrow[d, "\text{Invert}"] \\
{} \arrow[r, "\text{Marginalize}"'] & \text{get } p(\theta)
\end{tikzcd}
$$

get $p(\theta)$ (Conf. distn from measuring variable

Marginalize → get "conf" distn (by integrating full distn

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<u>Marginalize</u> ... to be relevent to interest parameter

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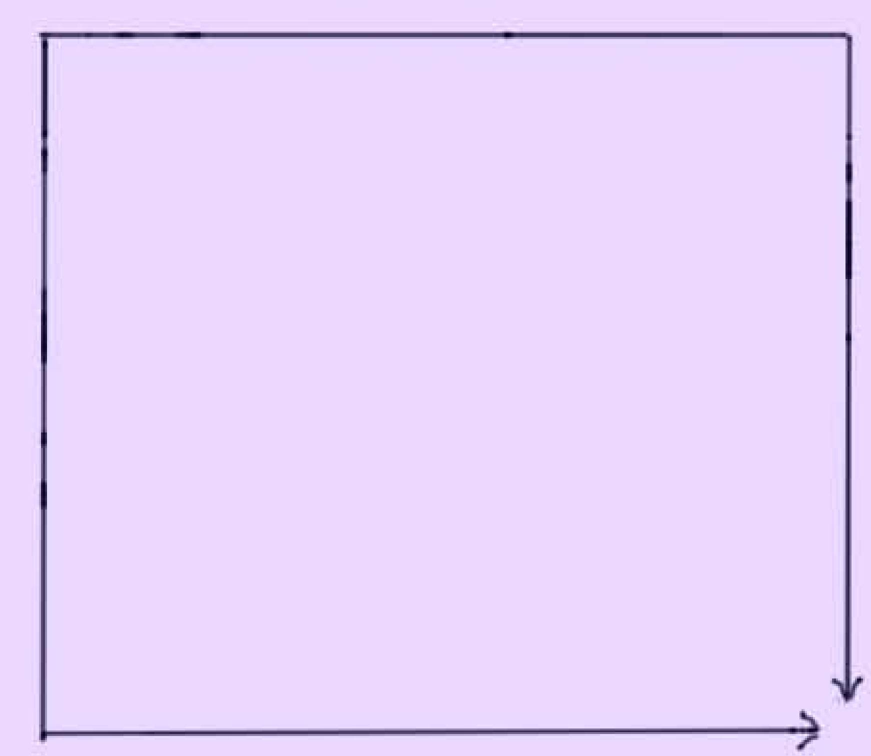
Marginalize →

Interest in ψ Model
Data



Invert ↓ (left)   Invert ↓ (right)

get $p(\theta)$ (Conf. distn
from measuring variable

Marginalize →   get conf distn (by integrating full distn

and they are radically different!

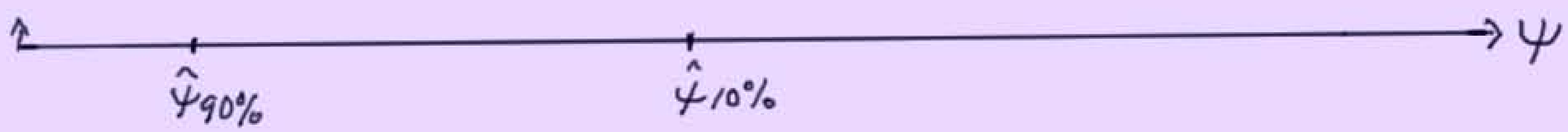
Discussion

Interest ψ scalar

Nuisance λ

Data ... Joint distn (ψ, λ)
Marginal for ψ

Get



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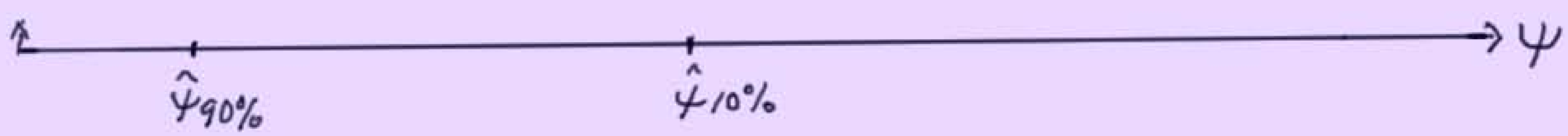

But dist'n depends only on s

Conf dist'n from s gives:

Discussion.

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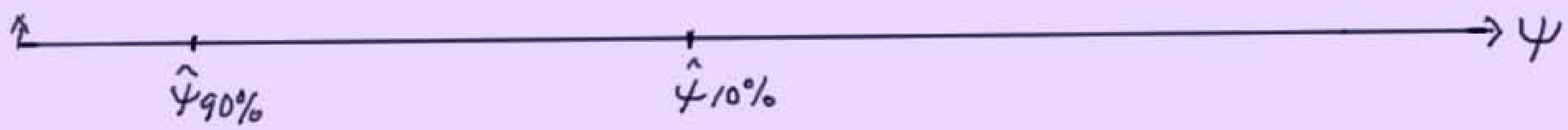

But dist'n depends only on s

Conf dist'n from s gives:

Which do you report ?

First has reproducibility !

Second does't

Can a calculation from a vector parameter distribution (pivot / flat Bayes / Jeffreys) give reproducible statements concerning true value of interest parameter $\psi(\theta)$?

- Yes, but reliably only for scalar interest ψ
- Such p-values (frequency) <u>are</u> available by conditioning
- Continuity determines such conditioning
- Should not try to obtain such from vector parameter distributions by marginalization
- Parameter curvature is the culprit
- Jeffreys prior can be OK but use <u>only</u> on profile for scalar interest