Measuring Deviations from Theories of Choice Under Risk and Uncertainty

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IECON — July 2023

Work in progress!!

Revealed preference theory asks

When are agent's choices consistent with utility maximization?

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about general utility maximization

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Recent theory is about specific functional forms

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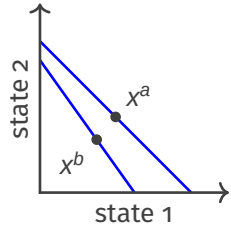
When are agent's choices consistent with utility maximization?

about general utility maximization

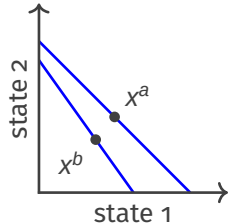
Recent theory is about specific functional forms

This talk expected utility


state 2
state 1
x^a
x^b

$$\max \sum_{s \in S} {}_s u(x_s)$$

$$\text{s.t.:} \sum_{s \in S} p_s x_s \leq I$$



When are choices from budget sets (x^k, p^k), $k = a, b$, consistent with EU?

$$\max \sum_{s \in S} {}_s u(x_s)$$

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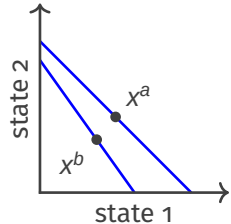


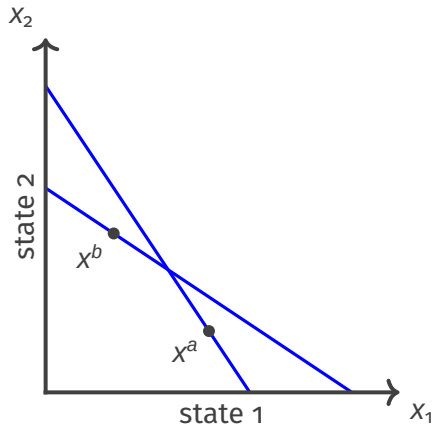
When are choices from budget sets (x^k, p^k), $k = a, b$, consistent with EU?

Can we find u (and) such that for each problem $k \; 2 \; \{a, b\}$

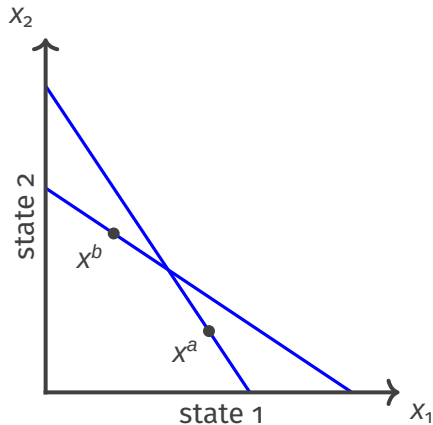
$$(x_1^k, x_2^k) \; 2 \; \underset{(x_1, x_2)}{\text{argmax}} \;\; {}_1 u(x_1) + {}_2 u(x_2)$$

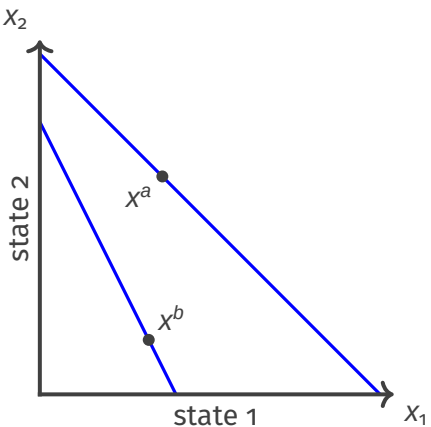
$$\text{s.t.:} \;\; p_1^k x_1 + p_2^k x_2 \;\; 6 \;\; p_1^k x_1^k + p_2^k x_2^k$$

Green and Srivastava (1986), Kübler et al. (2014), Echenique and Saito (2015), Polisson et al. (2020)


x_2
state 2
x^b
x^a
state 1
x_1

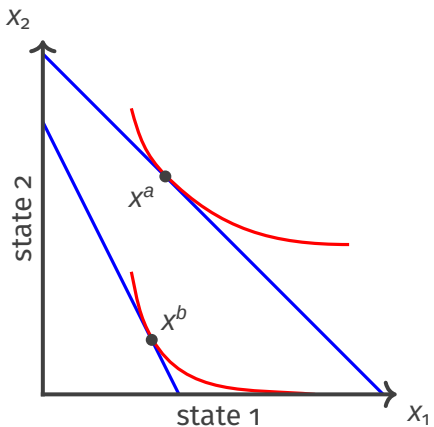
Violation of WARP





Risk-averse OEU agent solves

$$\max \quad {}_1u(x_1) + {}_2u(x_2)$$
$$\text{s.t.:} \quad p_1x_1 + p_2x_2 \;\; 6 \;\; I$$



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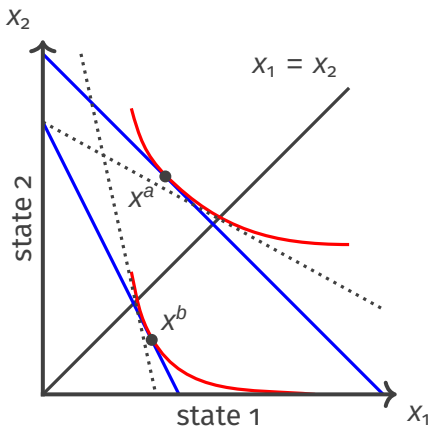
$$\text{MRS} = \frac{{}_1u'(x_1)}{{}_2u'(x_2)}$$



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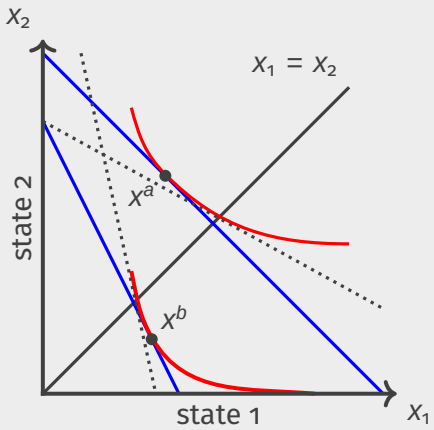
$$\text{MRS}j_{x_1=x_2} = \frac{{}_1u'(x_1)}{{}_2u'(x_2)} = \frac{1}{2}$$

... but ..... have different slopes

When are choices from budget sets consistent with EU?

Kübler et al. (2014), Echenique and Saito (2015)

Not



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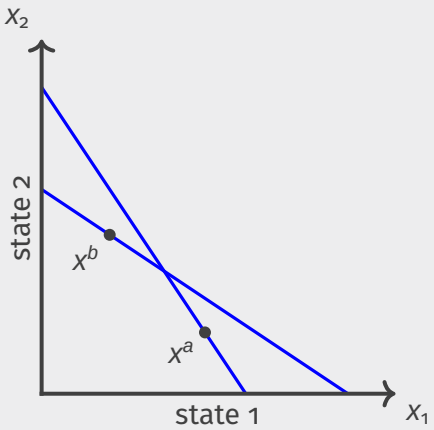
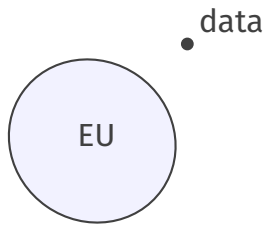
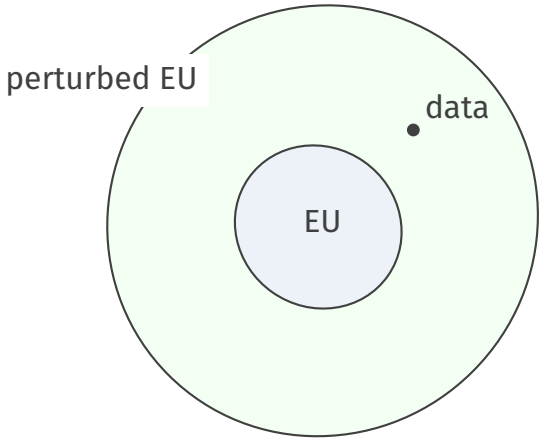
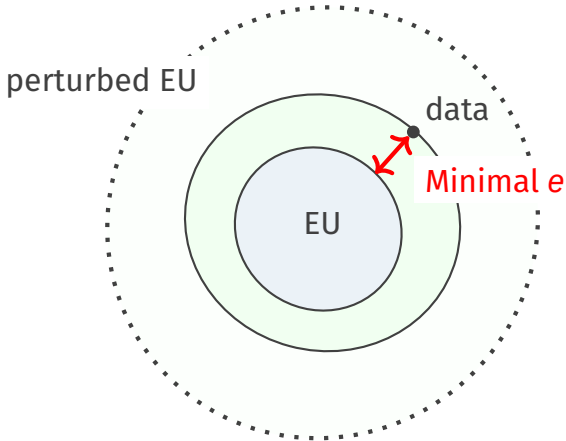



data
EU



Echenique, Imai, Saito (202x) *JEEA*



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1. Belief perturbation: ${}_s \quad e_s^k \;/\; {}_s^k \text{"}_s^k$

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□ Three ways of perturbation are equivalent

Minimal e

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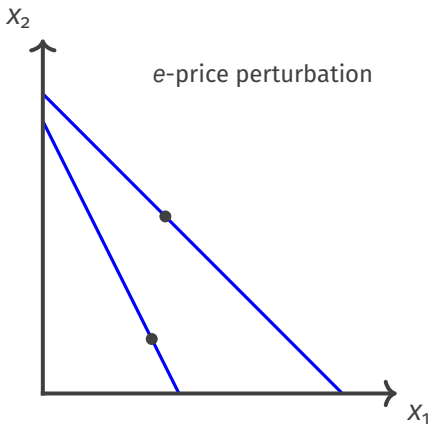

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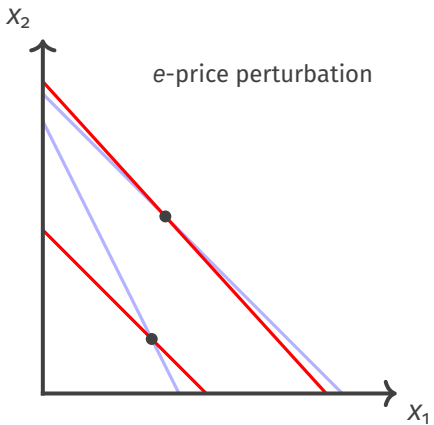

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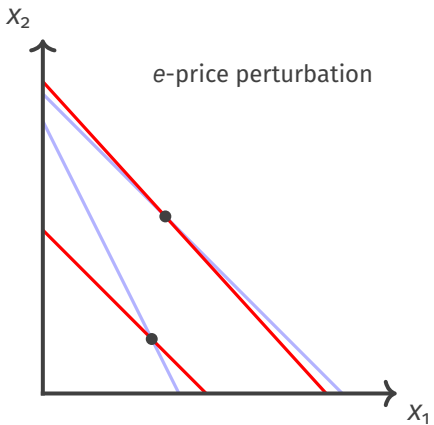
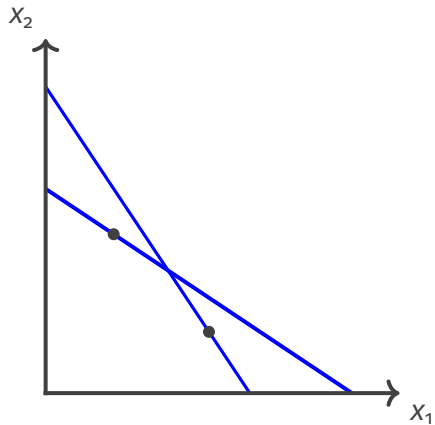


Critical cost efficiency index

Afriat-Varian



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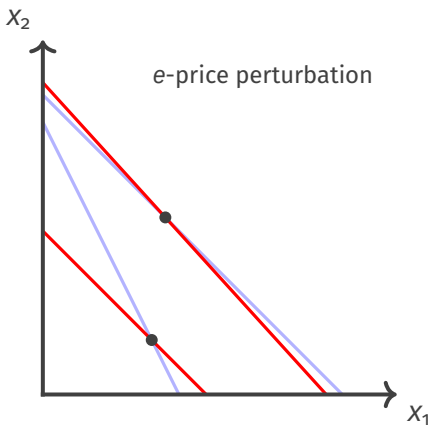

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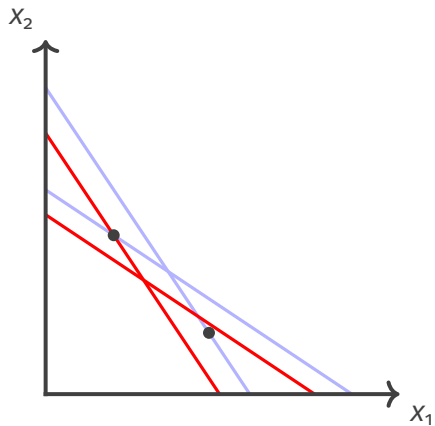

Experiments budgetary choice under risk

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Symmetric (50-50) environment, one-shot experiment

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2. To what extent are choices consistent with theories of U max?

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3. Are preferences stable? Are measures of consistency reliable?

Design

Investment task

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Two risky assets: Orange and Blue

each asset has a price: p_O and p_B

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$$p_O x_O + p_B x_B = 100$$

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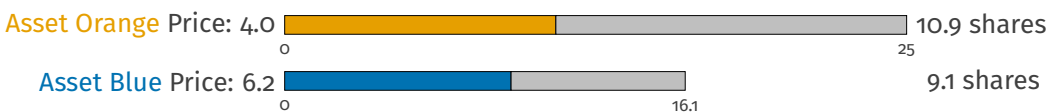

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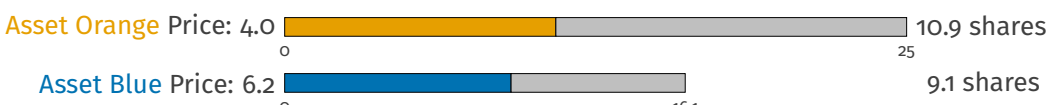
Payoff x_s if state $s \in \{O, B\}$ realizes



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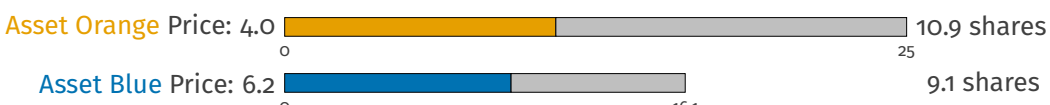
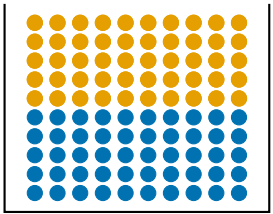
$_s$ = Pr(state s) or info about $_s$ varies by task



ObjSym



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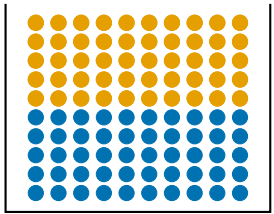
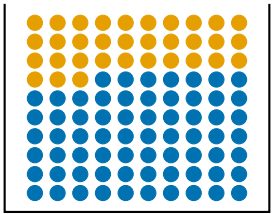
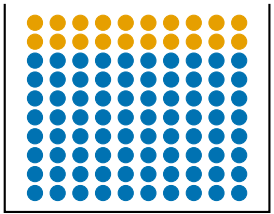


ObjAsymS



ObjAsymL



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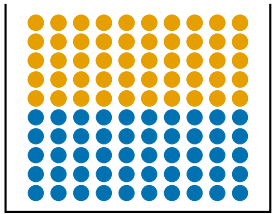

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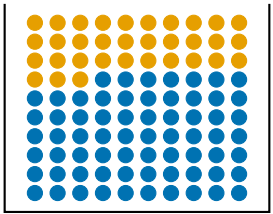

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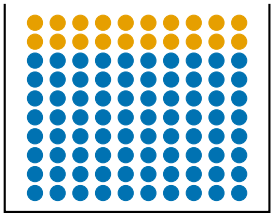
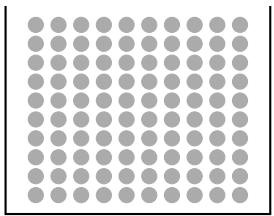


AmbFull



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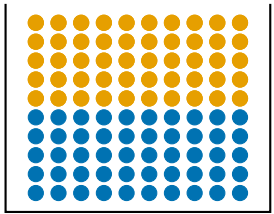

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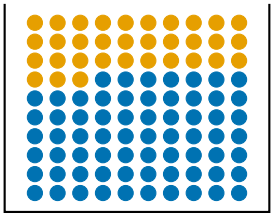

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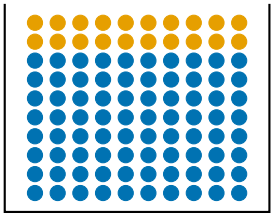

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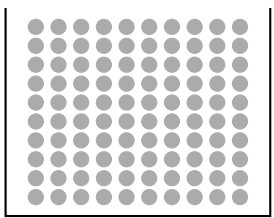

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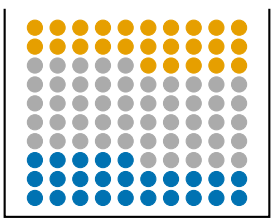

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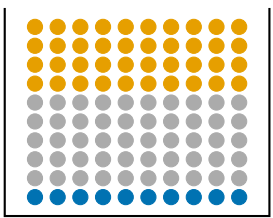

20 questions in each task

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3 sets of budget sets

- equalize "risk-neutral" prices ($p_s^{\text{rn}} = p_s = {}_s$) of 16 "core" budge sets across 3 Obj tasks
- same set used in ObjSym and Amb*

Echenique and Saito (2015), Kübler et al. (2014)

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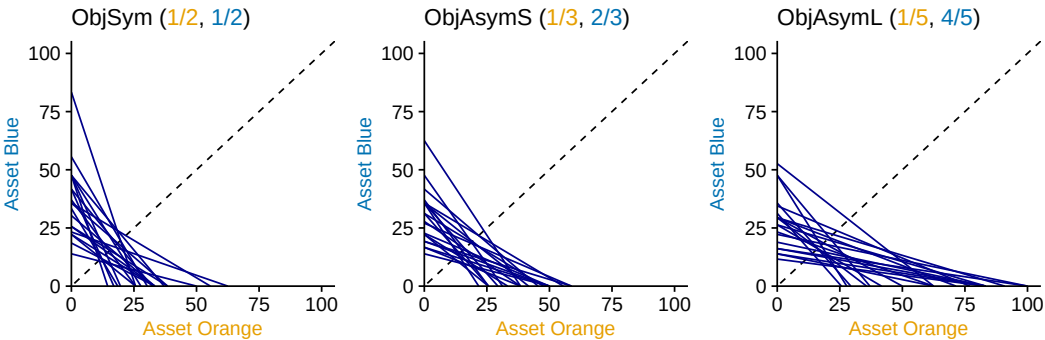
same set used in OBJSYM and AMB*



Study 1 effects of decision environment

Treatment	Task 1		Task 2	
1	ObjSym	(1/2, 1/2)	ObjAsymS	(1/3, 2/3)
2	ObjSym	(1/2, 1/2)	ObjAsymL	(1/5, 4/5)
3	ObjAsymS	(1/3, 2/3)	ObjAsymL	(1/5, 4/5)
4	ObjSym	(1/2, 1/2)	AmbFull	(0, 1, 0)
5	AmbFull	(0, 1, 0)	AmbSym	(1/4, 1/2, 1/4)
6	AmbFull	(0, 1, 0)	AmbAsym	(4/10, 5/10, 1/10)

- Task order randomized

Study 2 stability/reliability

Treatment	Task 1		Task 2	
1	ObjSym	(1/2, 1/2)	ObjSym	(1/2, 1/2)
2	ObjAsymS	(1/3, 2/3)	ObjAsymS	(1/3, 2/3)
3	AmbFull	(0, 1, 0)	AmbFull	(0, 1, 0)
4	AmbSym	(1/4, 1/2, 1/4)	AmbSym	(1/4, 1/2, 1/4)

Prolific (US sample)

$5 participation fee

1/5 “lucky” participants received additional bonus $$

- implemented 1 randomly-selected choice

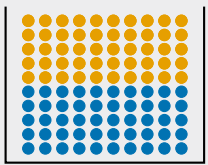
3121 participants in 10 treatments

- avg. 312 participants (min 268, max 352)
- avg. 37 years old
- 53% female

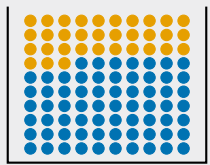
Results

Study 1: Sensitivity to decision environment

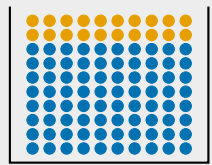
ObjSym



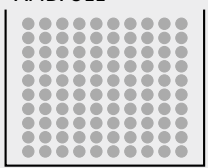
ObjAsymS



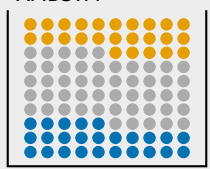
ObjAsymL



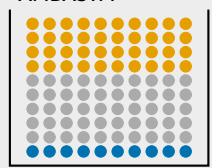
AmbFull

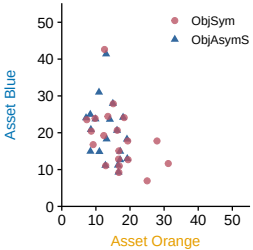


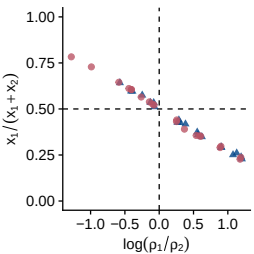
AmbSym

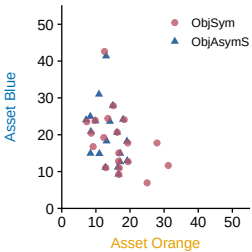


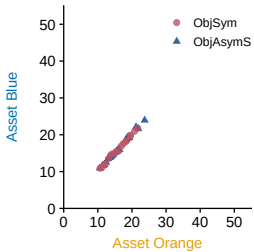
AmbAsym

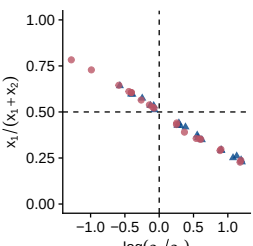


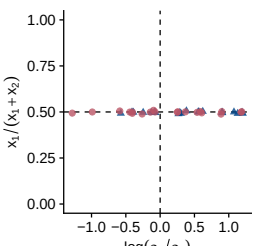

ObjSym
ObjAsymS
Asset Blue
Asset Orange
0
10
20
30
40
50

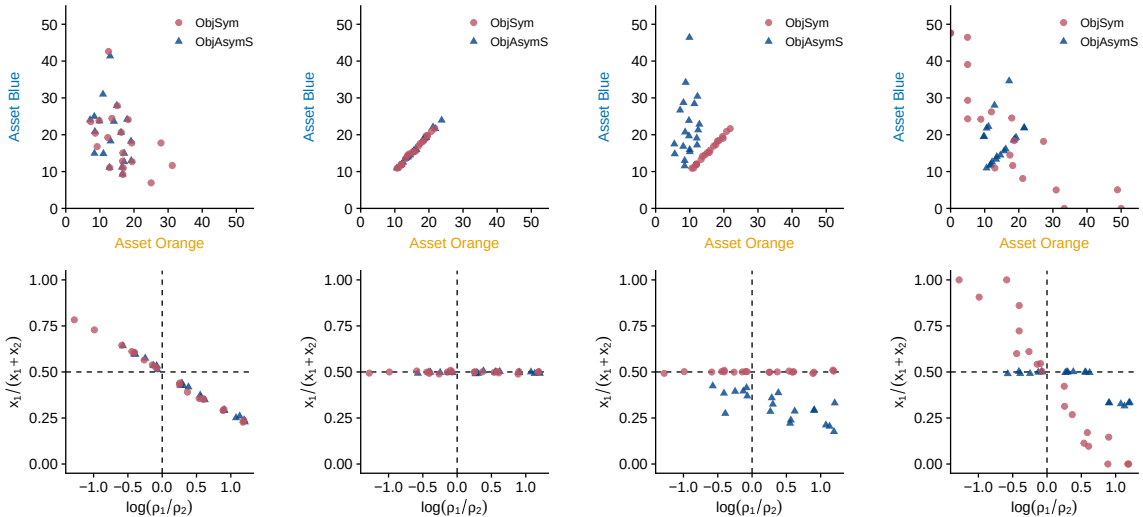

$x_1/(x_1+x_2)$
$\log(\rho_1/\rho_2)$
0.00
0.25
0.50
0.75
1.00
−1.0
−0.5
0.0
0.5
1.0

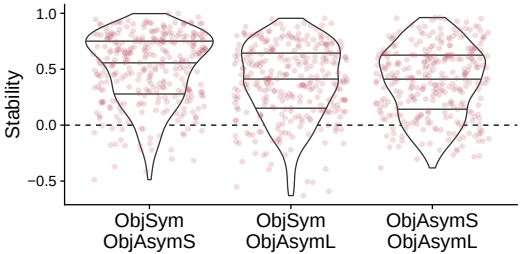

ObjSym
ObjAsymS
Asset Blue
Asset Orange
0
10
20
30
40
50

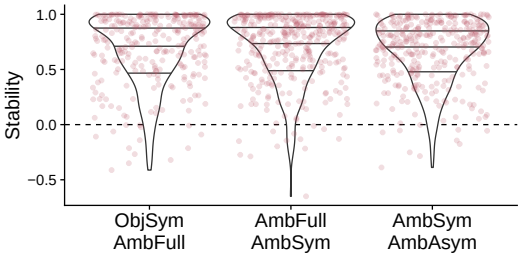

ObjSym
ObjAsymS
Asset Blue
Asset Orange
0
10
20
30
40
50


x1/(x1+x2)
log(ρ1/ρ2)
0.00
0.25
0.50
0.75
1.00
−1.0
−0.5
0.0
0.5
1.0


x1/(x1+x2)
log(ρ1/ρ2)
0.00
0.25
0.50
0.75
1.00
−1.0
−0.5
0.0
0.5
1.0

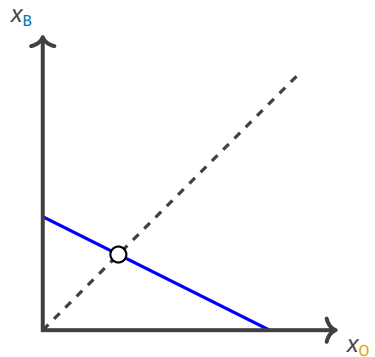

ObjSym
ObjAsymS
Asset Blue
Asset Orange
0
10
20
30
40
50
$x_1/(x_1+x_2)$
0.00
0.25
0.50
0.75
1.00
$\log(\rho_1/\rho_2)$
−1.0
−0.5
0.0
0.5
1.0

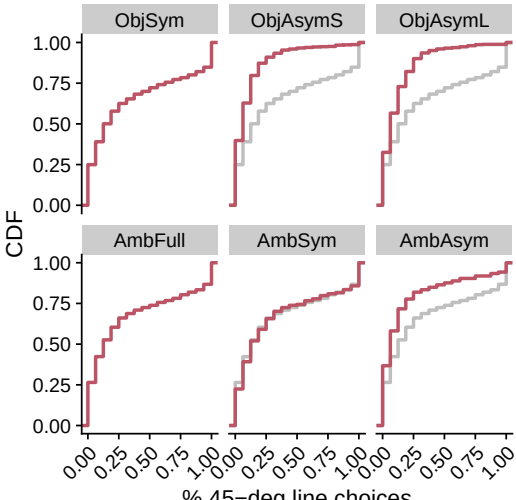




Correlation between choices made in two tasks

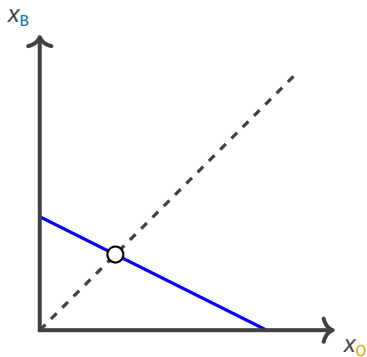
Choices on/close to the 45-deg line (x_O x_B) eliminate risk

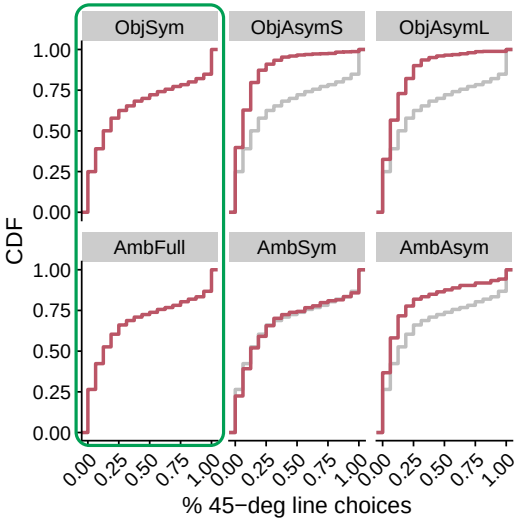




* Gray lines represent CDF in ObjSym (top) or CDF in AmbFull (bottom)

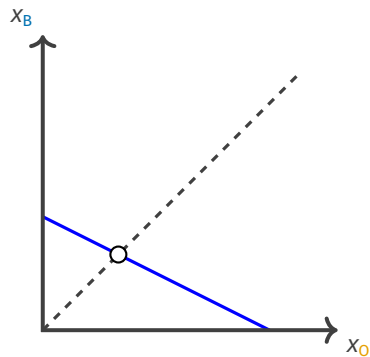
Choices on/close to the 45-deg line (x_O x_B) eliminate risk

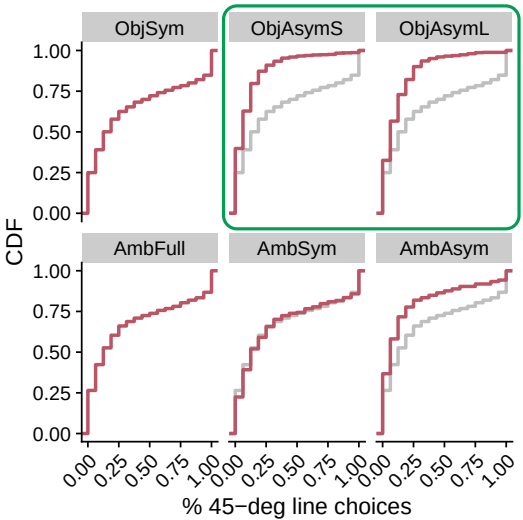




* Gray lines represent CDF in ObjSym (top) or CDF in AmbFull (bottom)

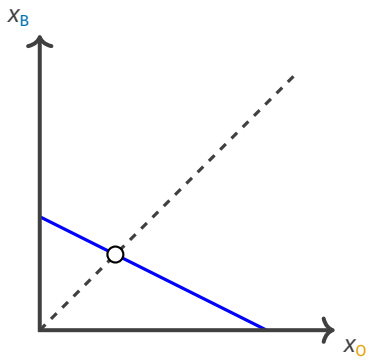
Choices on/close to the 45-deg line (x_O x_B) eliminate risk





* Gray lines represent CDF in ObjSym (top) or CDF in AmbFull (bottom)

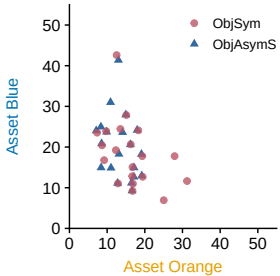
Choices on/close to the 45-deg line (x_O x_B) eliminate risk

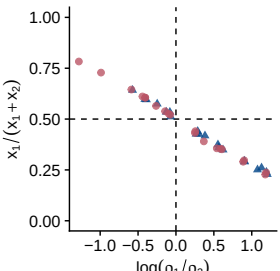


Downward-sloping demand sensitivity to price changes

$$\text{corr}\left(\log(x_O/x_B), \log(p_O/p_B)\right)$$

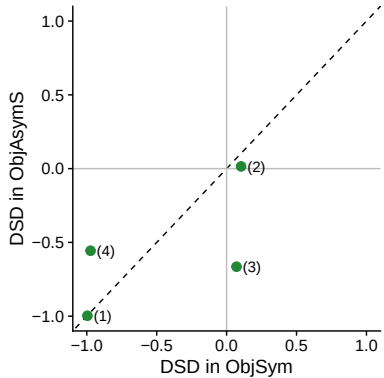
Example 1



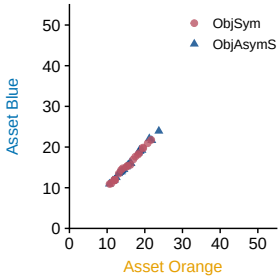


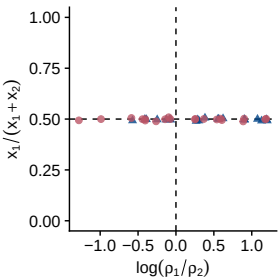
Downward-sloping demand
sensitivity to price changes

$\text{corr}\,(\log(x_O/x_B), \log(p_O/p_B))$



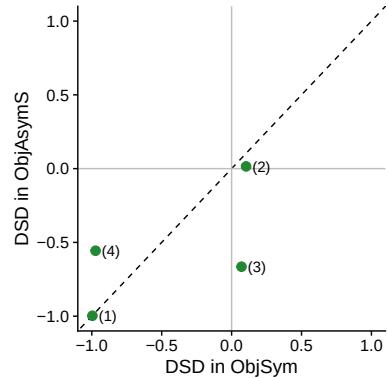
Example 2



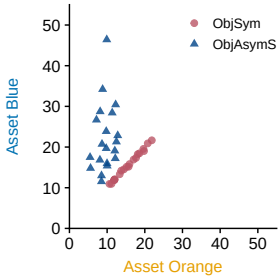


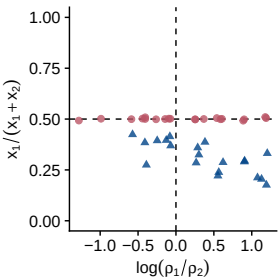
Downward-sloping demand
sensitivity to price changes

$\text{corr}\,(\log(x_O/x_B), \log(p_O/p_B))$



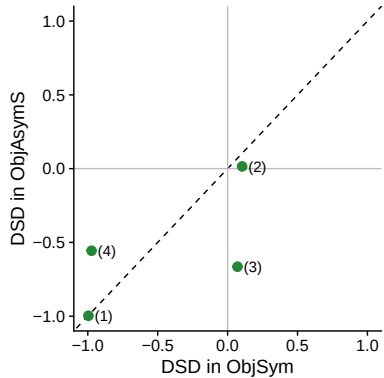
Example 3



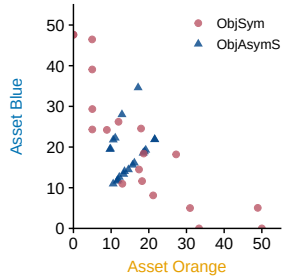


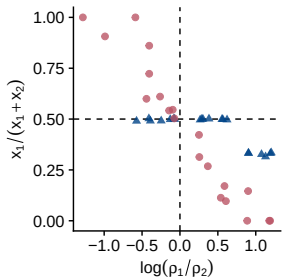
Downward-sloping demand
sensitivity to price changes

$\text{corr}\,(\log(x_O{=}x_B), \log(p_O{=}p_B))$



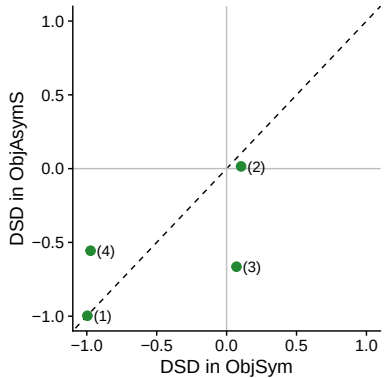
Example 4



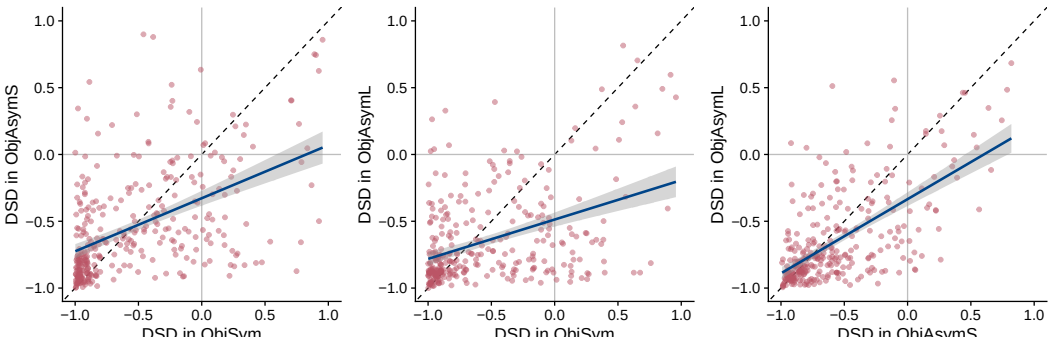


Downward-sloping demand
sensitivity to price changes

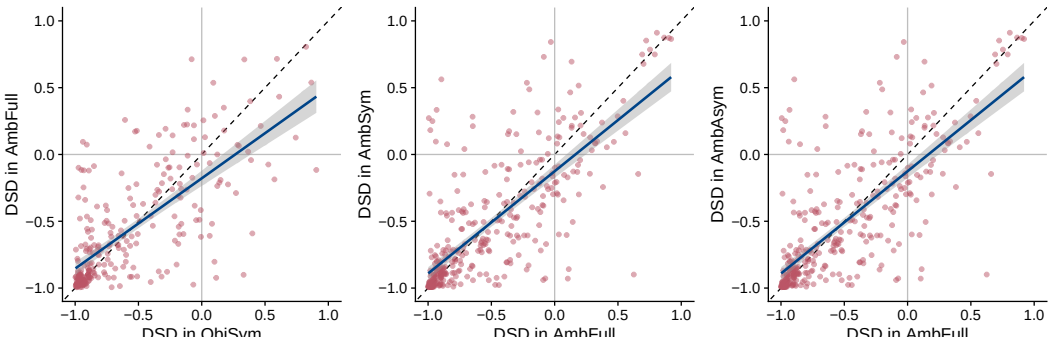
$\text{corr}\,(\log(x_O/x_B), \log(p_O/p_B))$



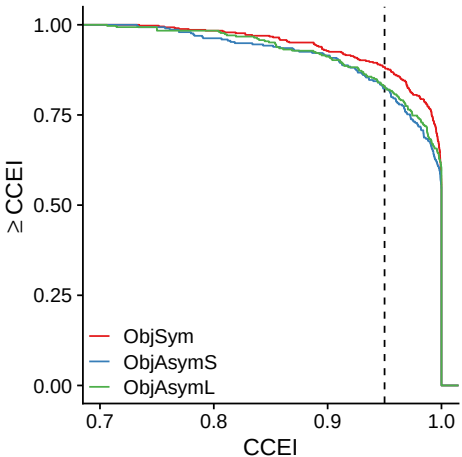
Objective probabilities: symmetric vs. asymmetric



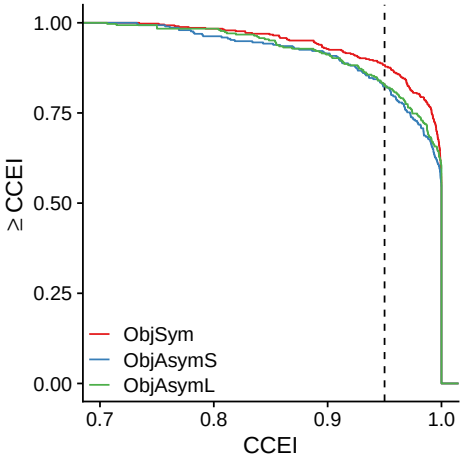
Full ambiguity vs. partial ambiguity

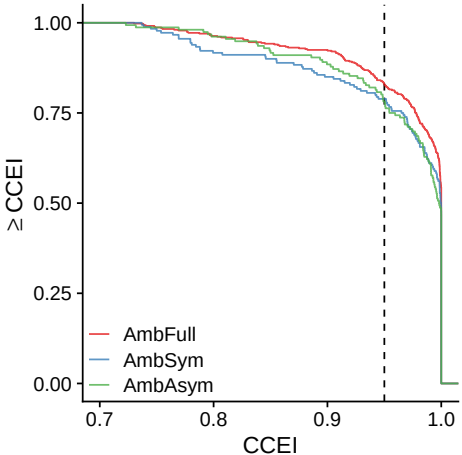


Measure of consistency: CCEI

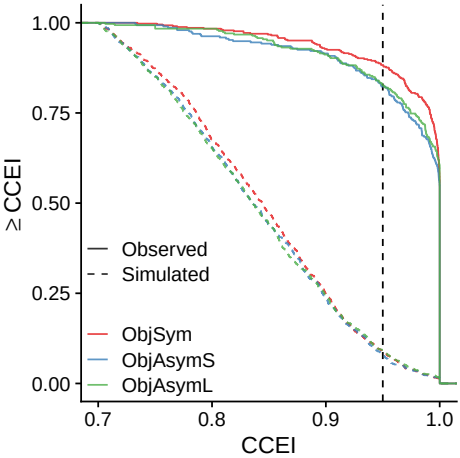


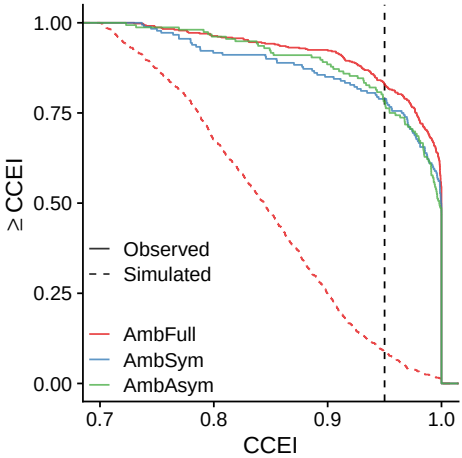
Measure of consistency: CCEI



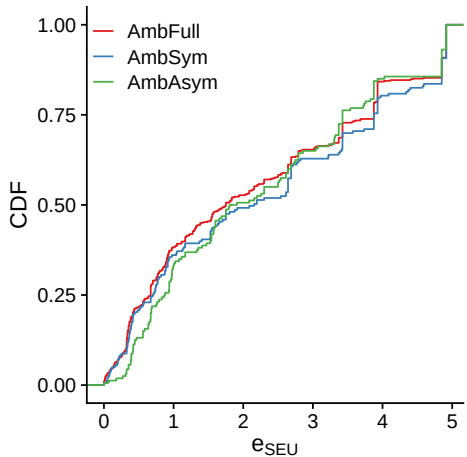


Measure of consistency: CCEI

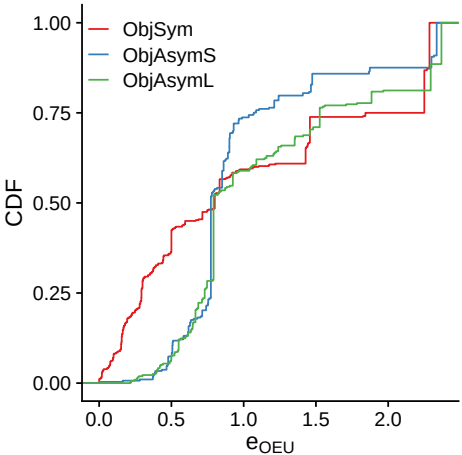


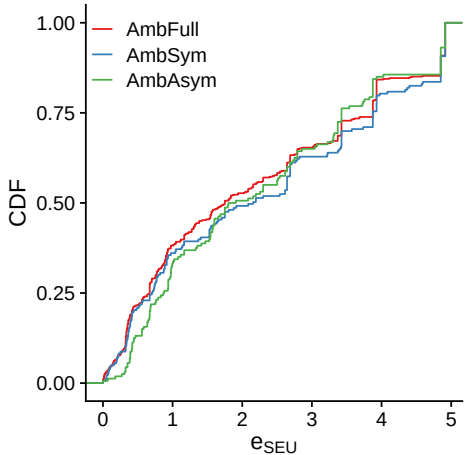


Measure of consistency: Minimal *e*

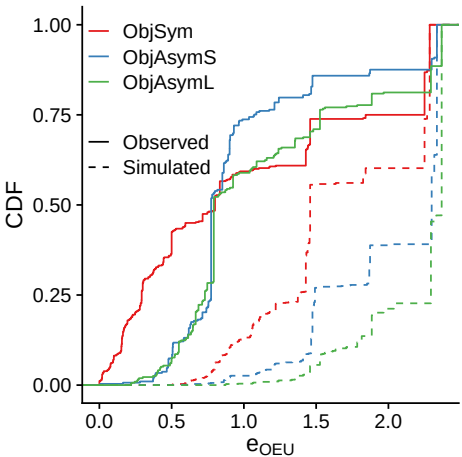


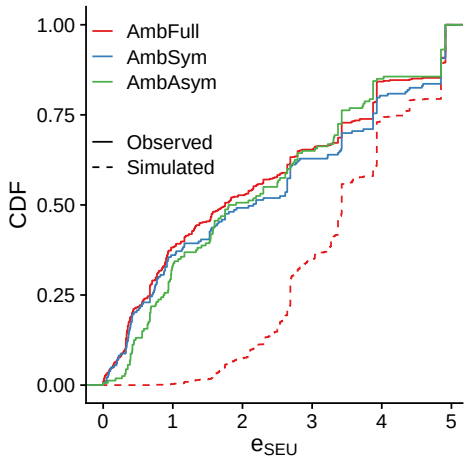
Measure of consistency: Minimal *e*

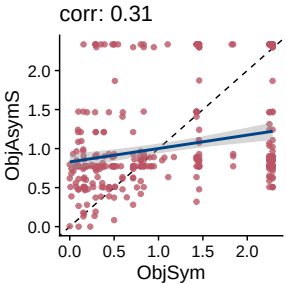




Measure of consistency: Minimal *e*



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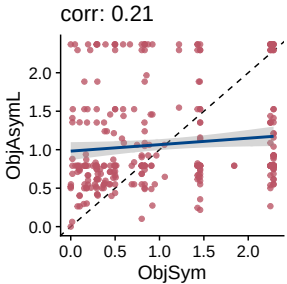
ObjAsymS
ObjSym
0.0
0.5
1.0
1.5
2.0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ObjAsymL
ObjSym
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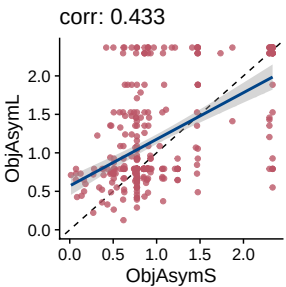
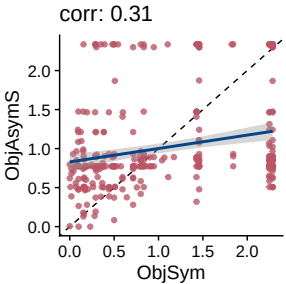
0.5
1.0
1.5
2.0


corr: 0.433
ObjAsymL
ObjAsymS
0.0
0.5
1.0
1.5
2.0


corr: 0.31
ObjAsymS
ObjSym
0.0
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1.0
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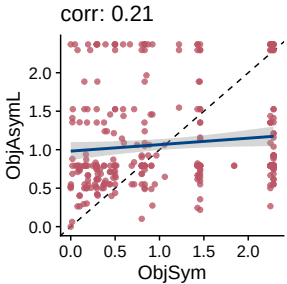
2.0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ObjAsymL
ObjSym
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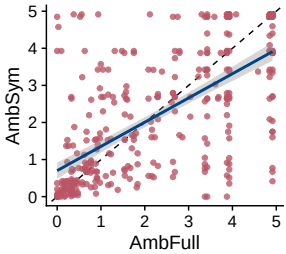
1.0
1.5
2.0


corr: 0.682
AmbSym
AmbFull
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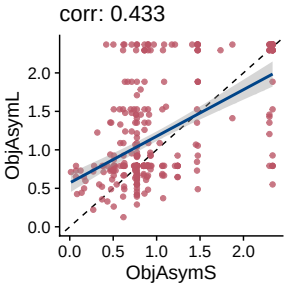
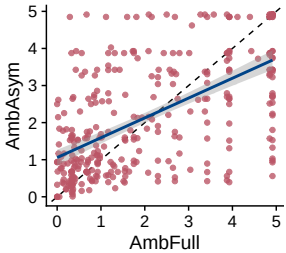
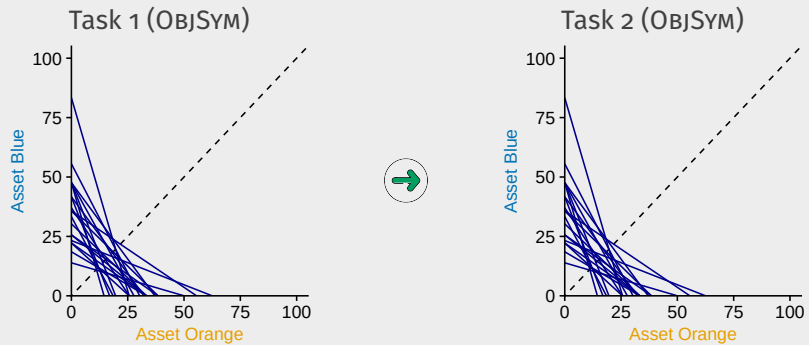
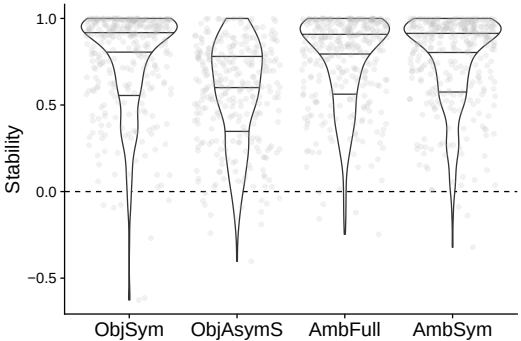
2
3
4
5


corr: 0.433
ObjAsymL
ObjAsymS
0.0
0.5
1.0
1.5
2.0

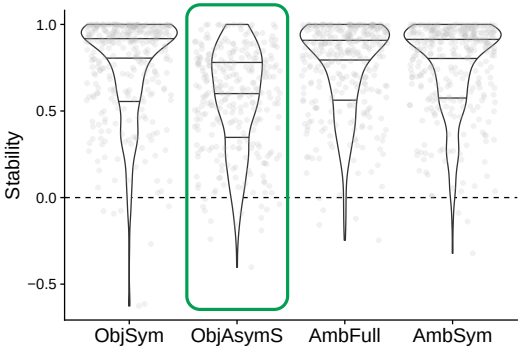

corr: 0.586
AmbAsym
AmbFull
0
1
2
3
4
5

Study 2: Stability of preferences



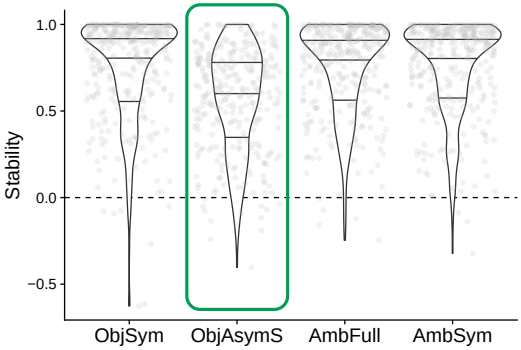


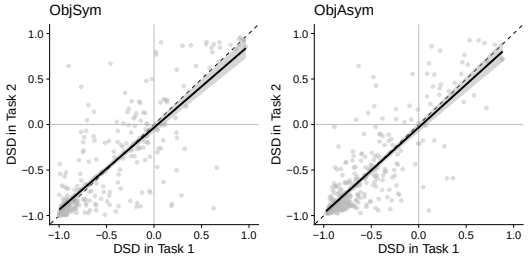
High correlation between choices made in two tasks



High correlation between choices made in two tasks

... except for ObjAsym





High correlation between choices made in two tasks

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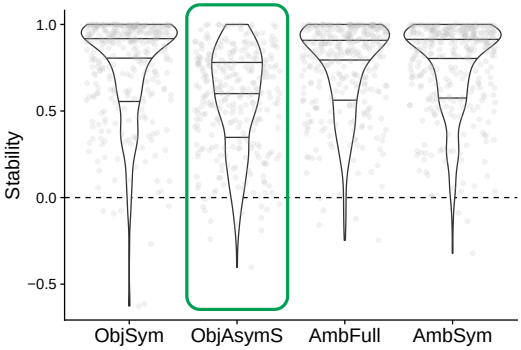

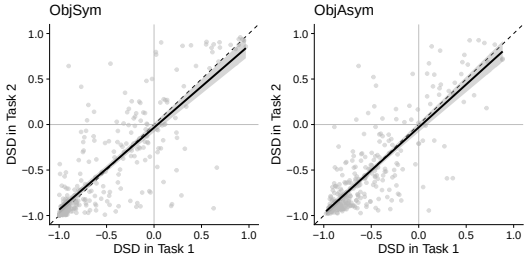

High correlation between choices made in two tasks

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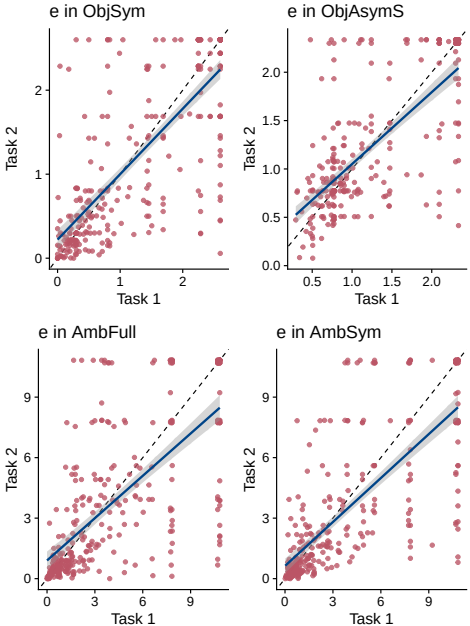

High correlation between *e* from two tasks

1. Do choices individuals make satisfy RP axioms?

   ... and how are they influenced by the environment?

2. To what extent are choices consistent with theories of U max?

   ... and how are they influenced by the environment?

3. Are preferences stable? Are measures of consistency reliable?

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Across tasks

participants responded to asymmetry
ObjSym and AmbFull were treated similarly

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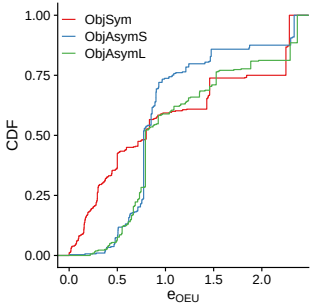
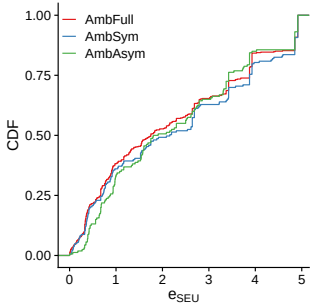
Across tasks

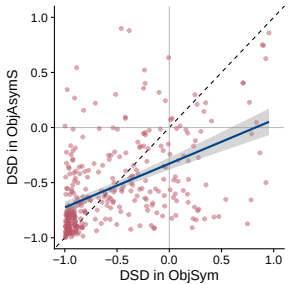
- participants responded to asymmetry
- ObjSym and AmbFull were treated similarly

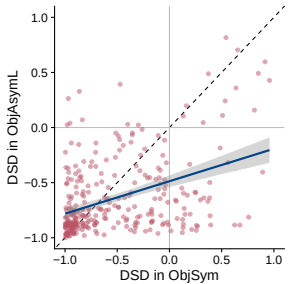
Within task

- stable choice patterns









- Comments / Questions
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