

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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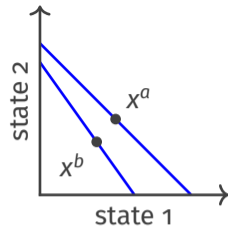
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- Revealed preference theory asks

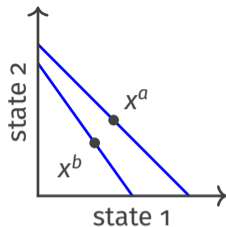
When are agent's choices consistent with utility maximization?

↪ about general utility maximization

- Recent theory is about specific functional forms
- This talk ↪ **expected utility**

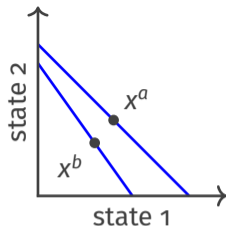


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- When are **choices from budget sets** (x^k, p^k) , $k = a, b$, consistent with EU?

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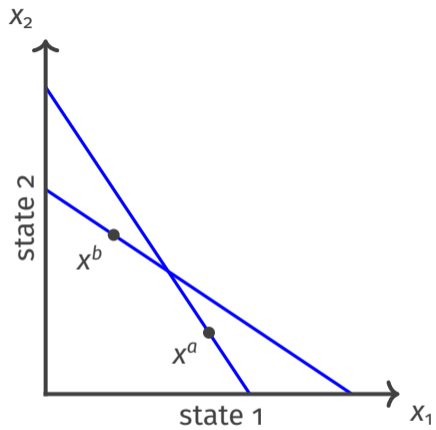


- When are **choices from budget sets** (x^k, p^k) , $k = a, b$, consistent with EU?
- Can we find u (and μ) such that for each problem $k \in \{a, b\}$

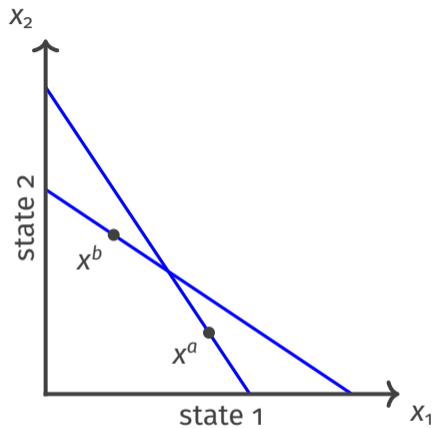
$$(x_1^k, x_2^k) \in \operatorname{argmax}_{(x_1, x_2)} \mu_1 u(x_1) + \mu_2 u(x_2)$$

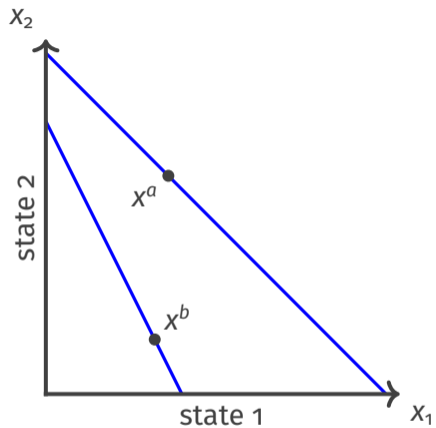
$$\text{s. t. } p_1^k x_1 + p_2^k x_2 \leq p_1^k x_1^k + p_2^k x_2^k$$

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



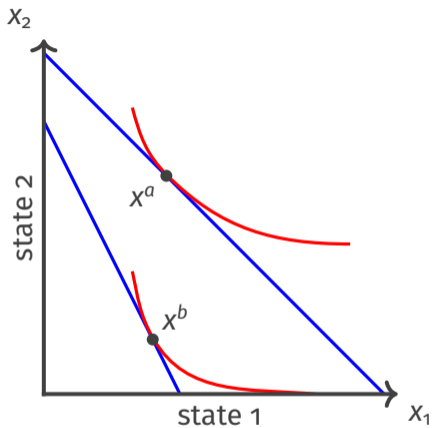
- Violation of WARP





- Risk-averse OEU agent solves

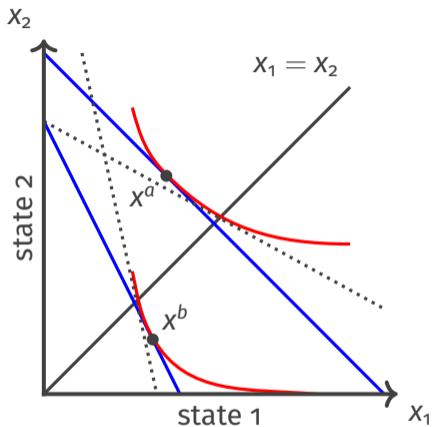
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- MRS $= \frac{\mu_1 u'(x_1)}{\mu_2 u'(x_2)}$



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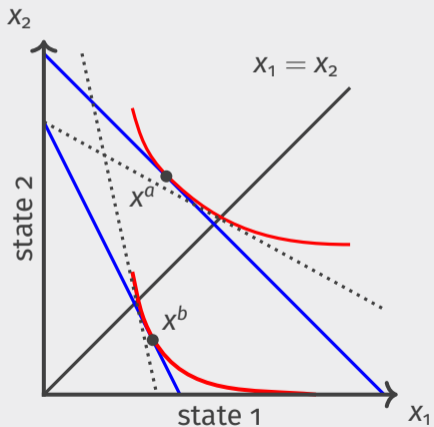
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- $MRS|_{x_1=x_2} = \frac{\mu_1 u'(x_1)}{\mu_2 u'(x_2)} = \frac{\mu_1}{\mu_2}$
... but have different slopes

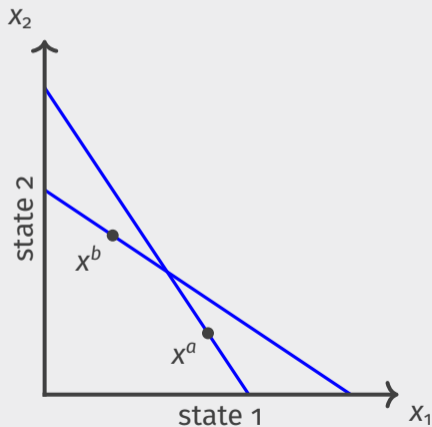
- When are choices from budget sets consistent with EU?

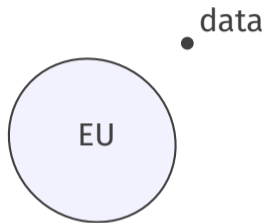
Kübler et al. (2014), Echenique and Saito (2015)

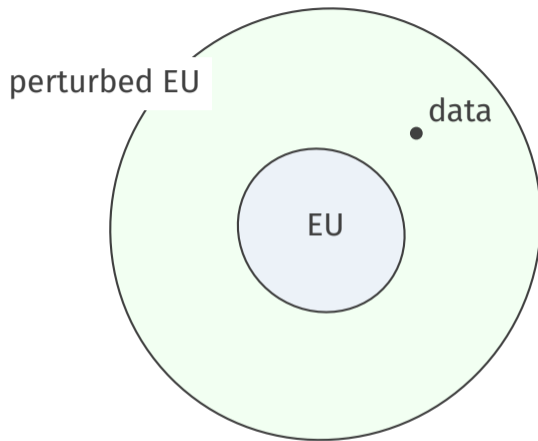
Not



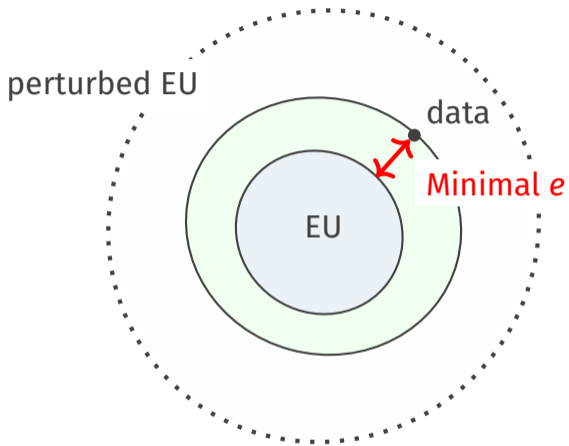
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Echenique, Imai, Saito (202x) *JEEA*



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$$\begin{aligned} \max_{x^k} \quad & \sum_{s \in S} \mu_s u(x_s^k) \\ \text{s. t.} \quad & \sum_{s \in S} p_s^k x_s^k \leq I, \quad k = 1, \dots, K \end{aligned}$$

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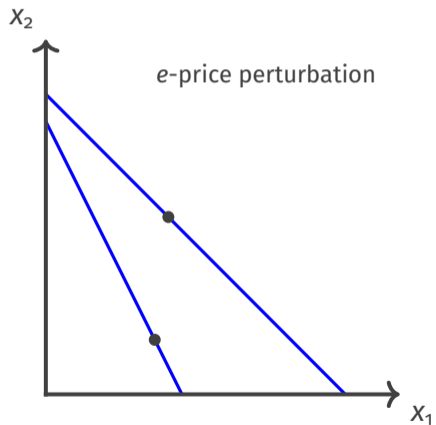
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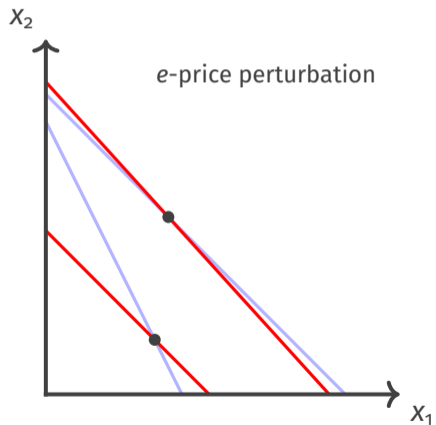
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❗ Three ways of perturbation are equivalent

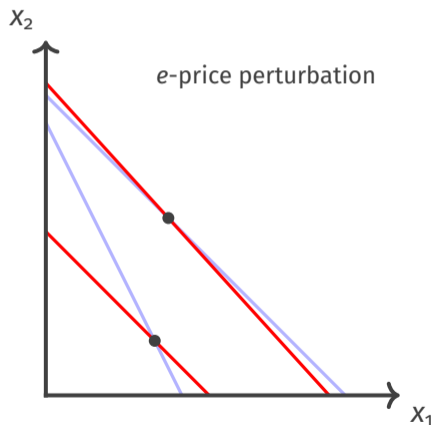
- Minimal e
Echenique et al. (202x) *JEEA*



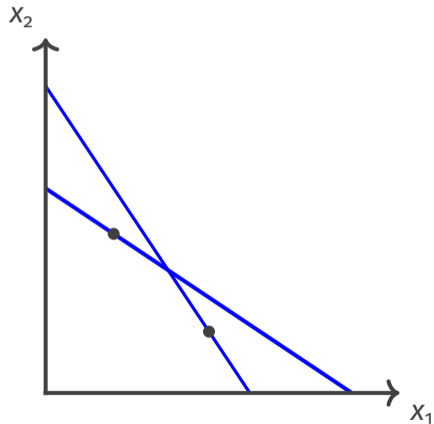
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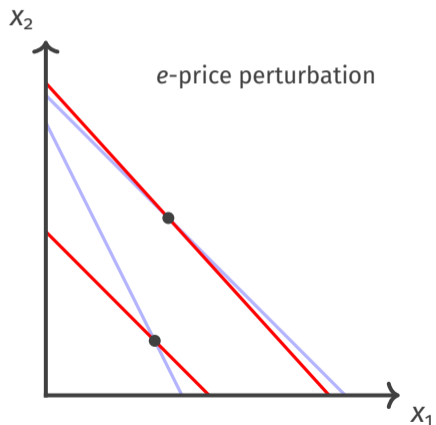
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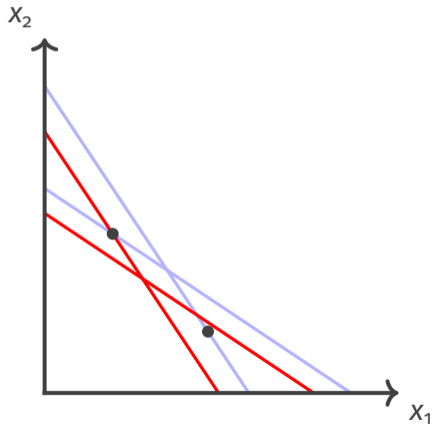
- Critical cost efficiency index
Afriat-Varian



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- Experiments \rightsquigarrow budgetary choice under risk

Choi et al. (2014)

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

1. Do choices individuals make satisfy **RP axioms**?
2. To what extent are choices **consistent** with theories of U max?

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

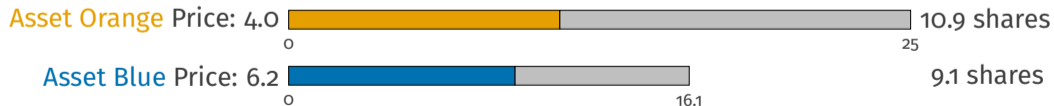
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- Two risky assets: Orange and Blue
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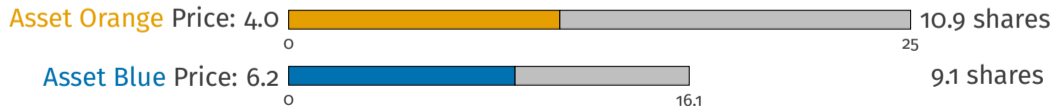
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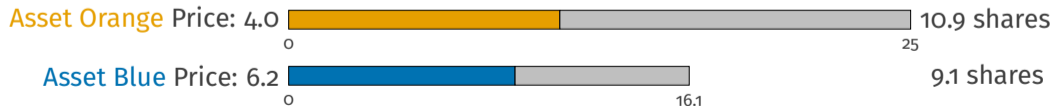
- **Payoff** x_s if state $s \in \{O, B\}$ realizes



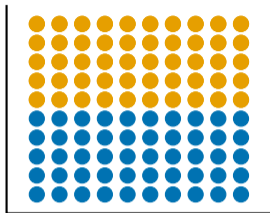
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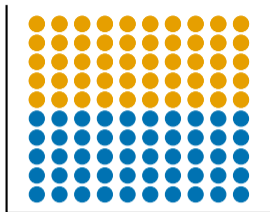
- Payoff x_s if state $s \in \{O, B\}$ realizes
- $\mu_s = \text{Pr}(\text{state } s)$ or **info about μ_s** varies by task



OBJSYM



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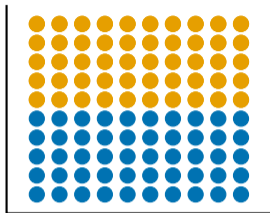
OBJASYMS



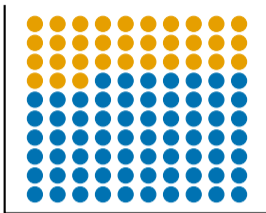
OBJASYML



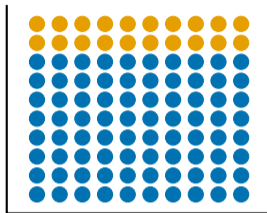
OBJSYM



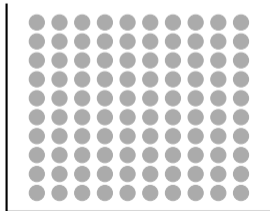
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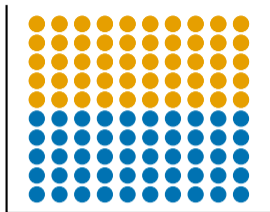
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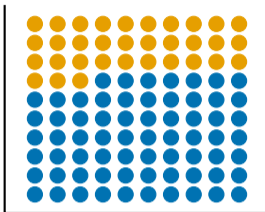
AMBFULL



OBJSYM



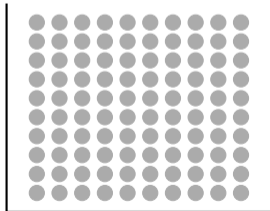
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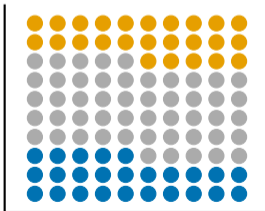
OBJASYML



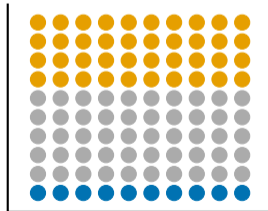
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AMBSYM



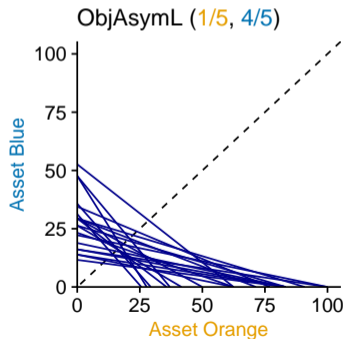
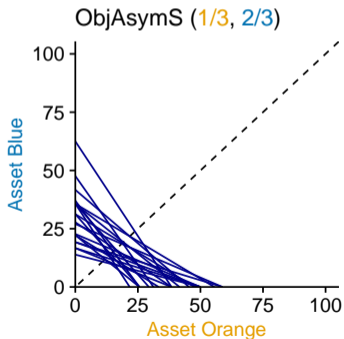
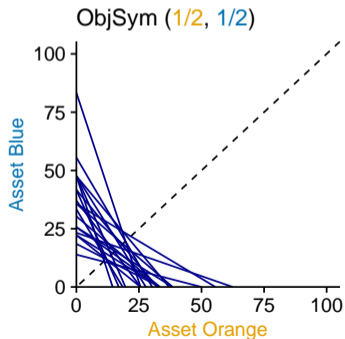
AMBASYM



- 20 questions in each task

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- 3 sets of budget sets
 - equalize “risk-neutral” prices ($p_s^{\text{rn}} = p_s / \mu_s$) of 16 “core” budget sets across 3 OBJ tasks Echenique and Saito (2015), Kübler et al. (2014)
 - same set used in OBJSYM and AMB*

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- Study 1 \rightsquigarrow 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 \rightsquigarrow stability/reliability

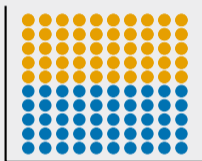
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2	OBJASYMS	(1/3, 2/3)	OBJASYMS	(1/3, 2/3)
3	AMBFULL	(0, 1, 0)	AMBFULL	(0, 1, 0)
4	AMBSYM	(1/4, 1/2, 1/4)	AMBSYM	(1/4, 1/2, 1/4)

- 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



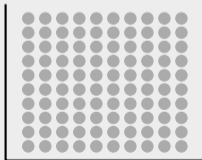
OBJASYMS



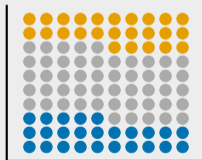
OBJASYML



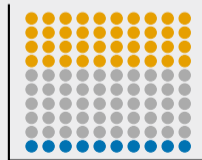
AMBFULL

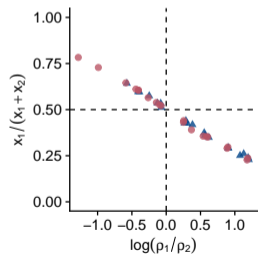
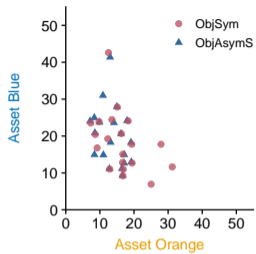


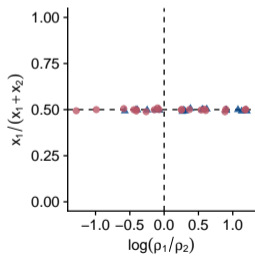
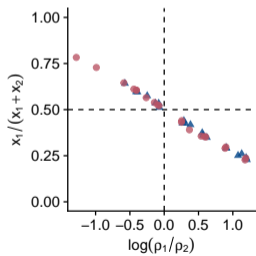
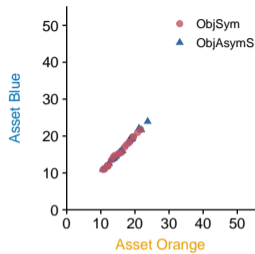
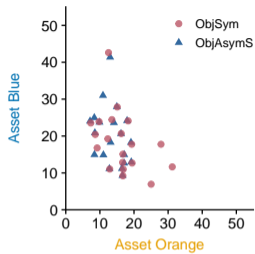
AMBSYM

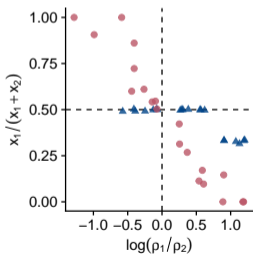
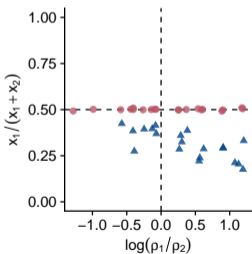
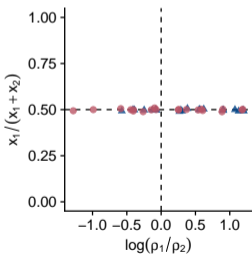
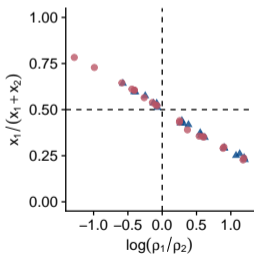
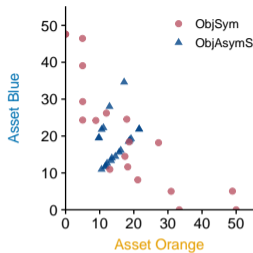
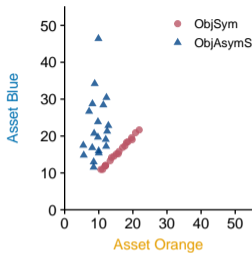
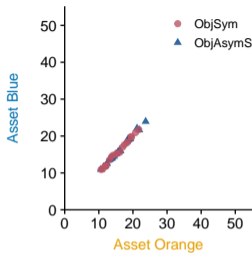
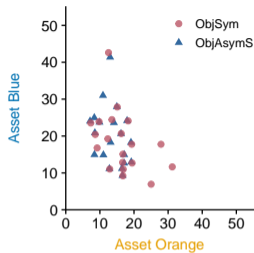


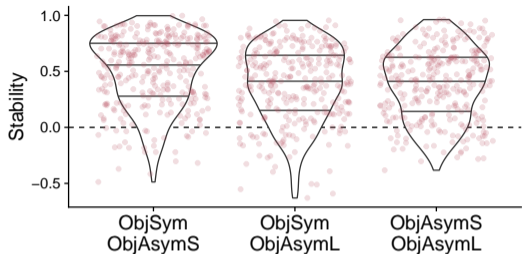
AMBASYM



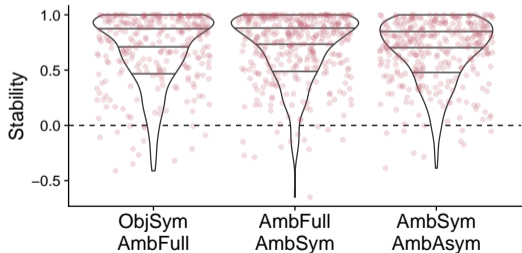




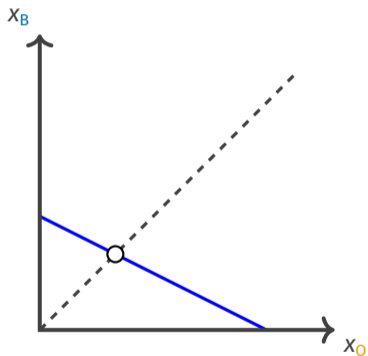


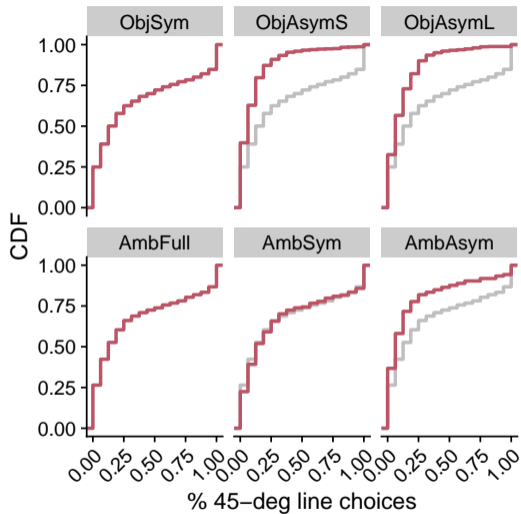


- Correlation between choices made in two tasks



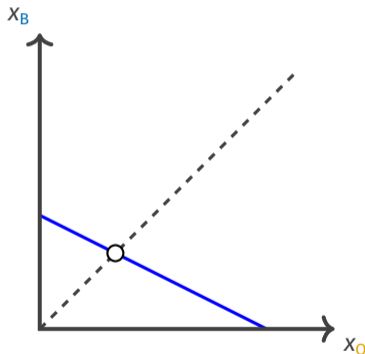
- Choices on/close to the 45-degree line ($x_O \approx x_B$) eliminate risk

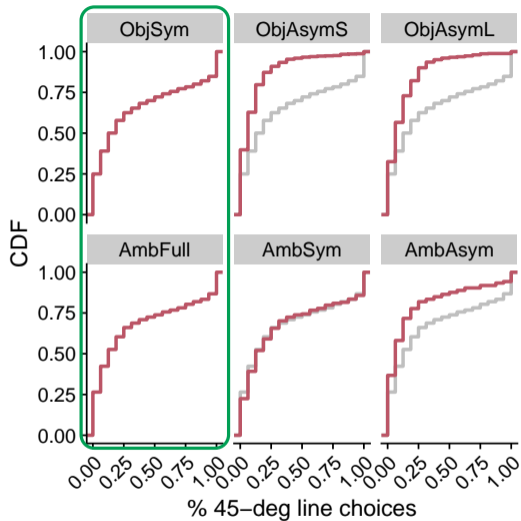




* Gray lines represent CDF in ObjSym (top) or CDF in AmbFull (bottom)

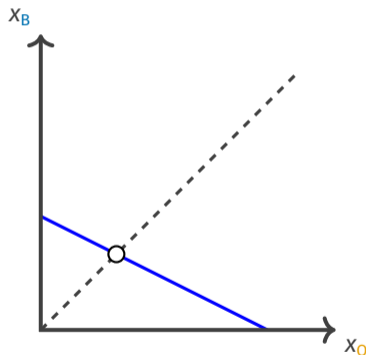
- Choices on/close to the 45-deg line ($x_O \approx x_B$) eliminate risk

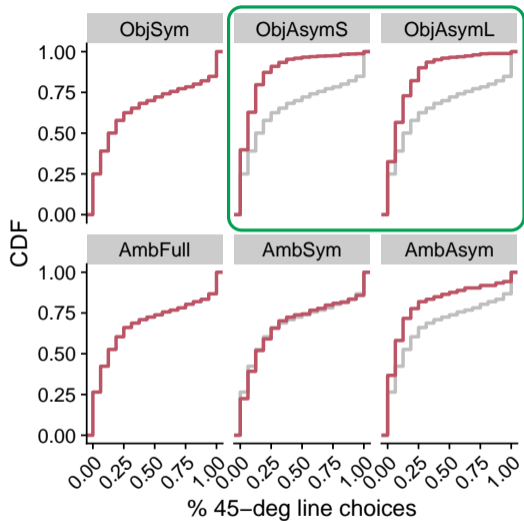




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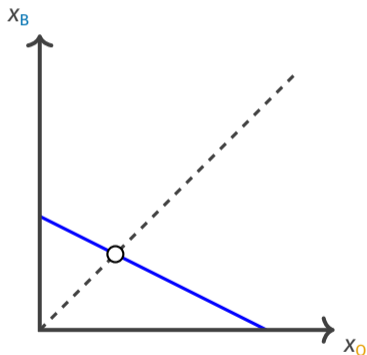
- Choices on/close to the 45-deg line ($x_O \approx x_B$) eliminate risk





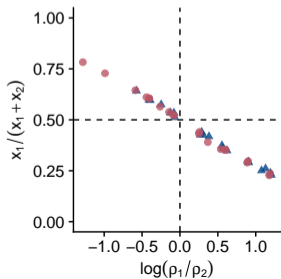
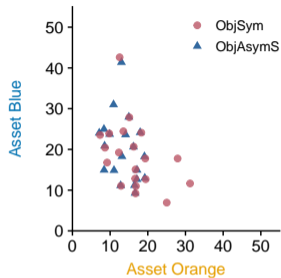
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- Choices on/close to the 45-deg line ($x_O \approx x_B$) eliminate risk

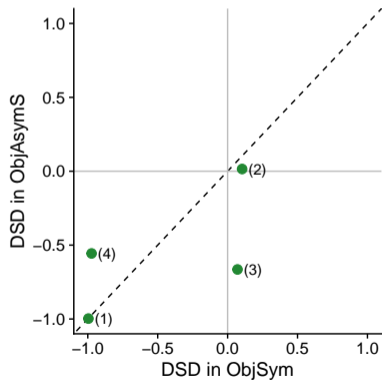


- Downward-sloping demand
 \rightsquigarrow sensitivity to price changes
- $\text{corr}(\log(x_O/x_B), \log(p_O/p_B))$

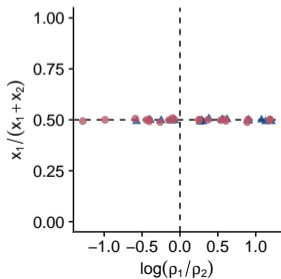
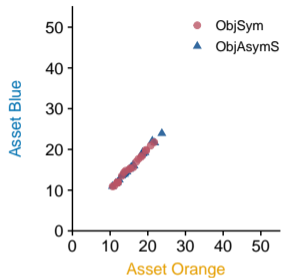
- Example 1



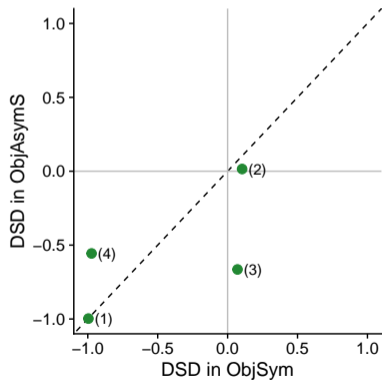
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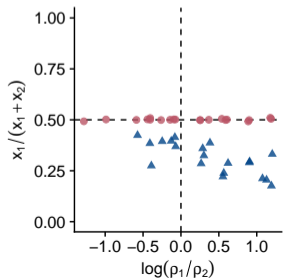
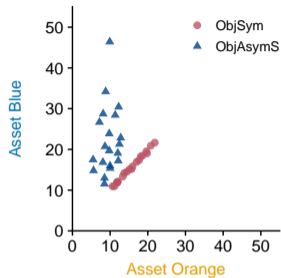
- Example 2



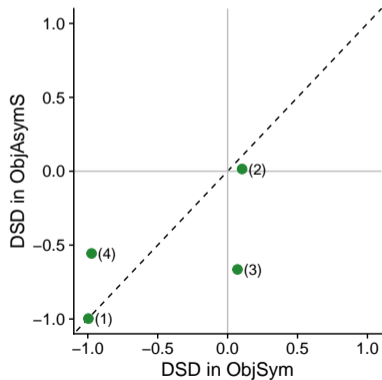
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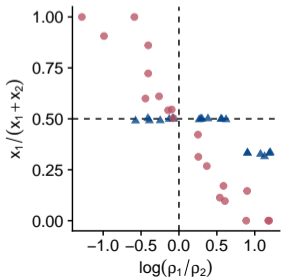
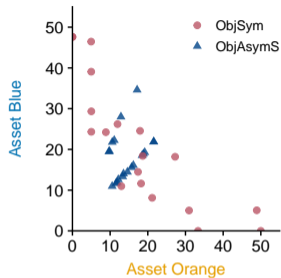
- Example 3



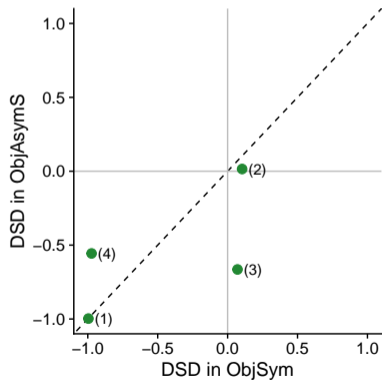
- Downward-sloping demand
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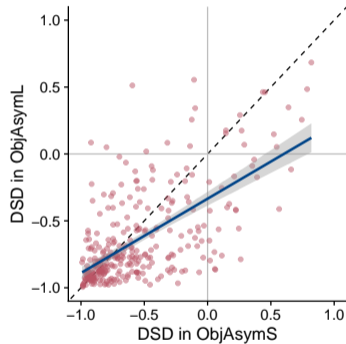
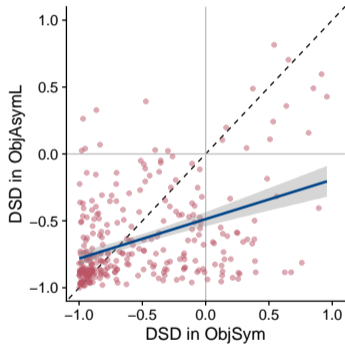
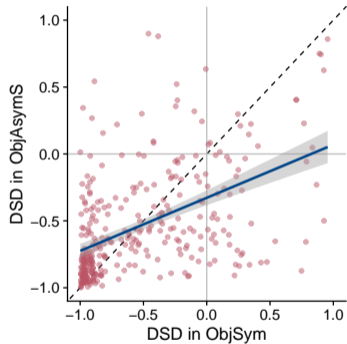
- Example 4



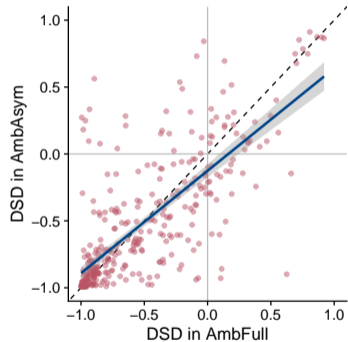
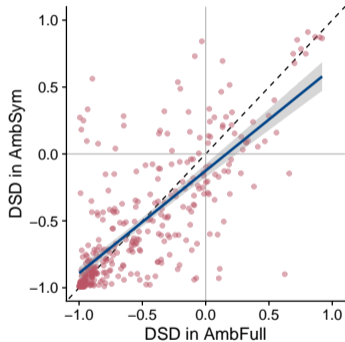
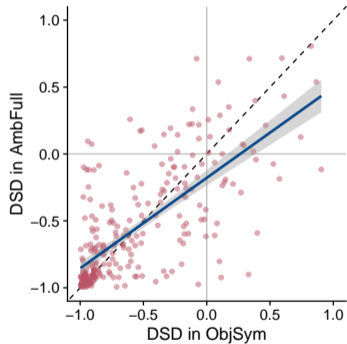
- Downward-sloping demand
 \rightsquigarrow sensitivity to price changes
- $\text{corr}(\log(x_O/x_B), \log(p_O/p_B))$



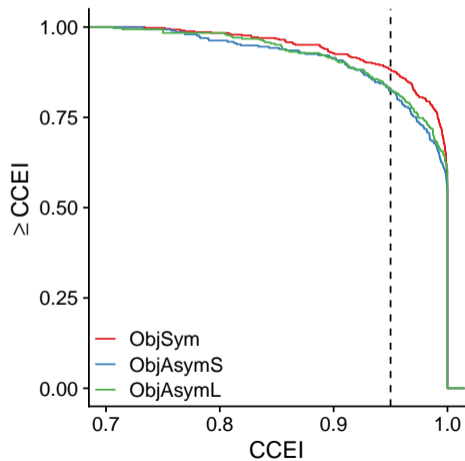
- Objective probabilities: symmetric vs. asymmetric



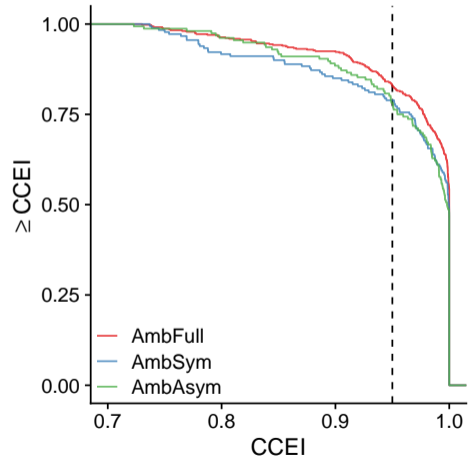
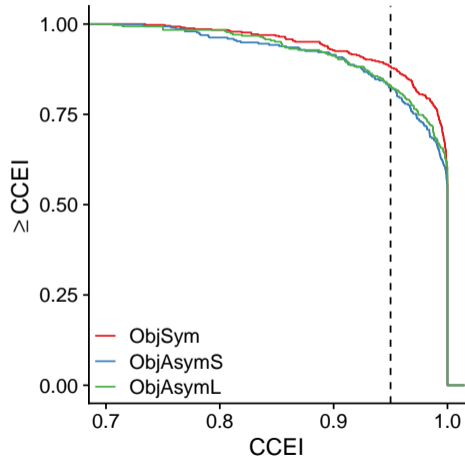
- Full ambiguity vs. partial ambiguity



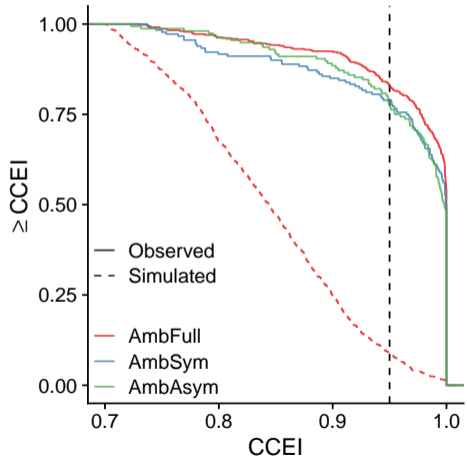
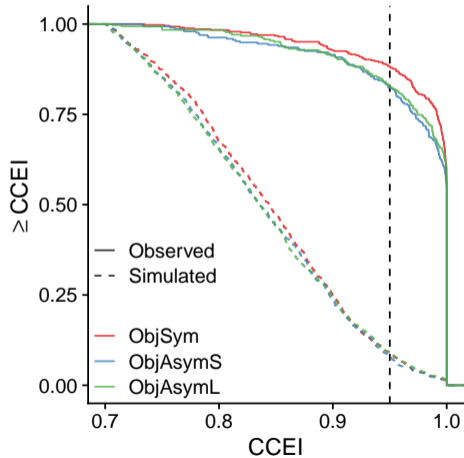
- Measure of consistency: CCEI



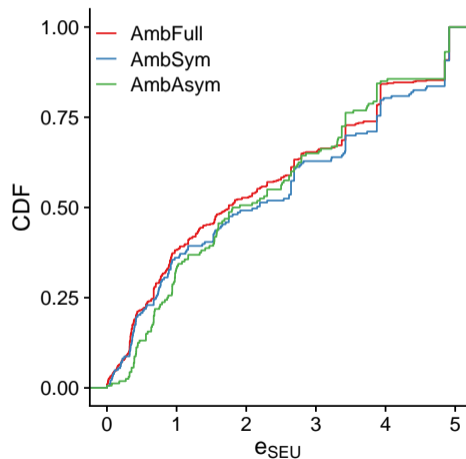
- Measure of consistency: CCEI



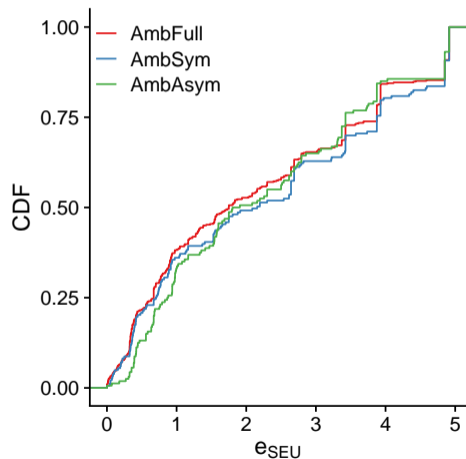
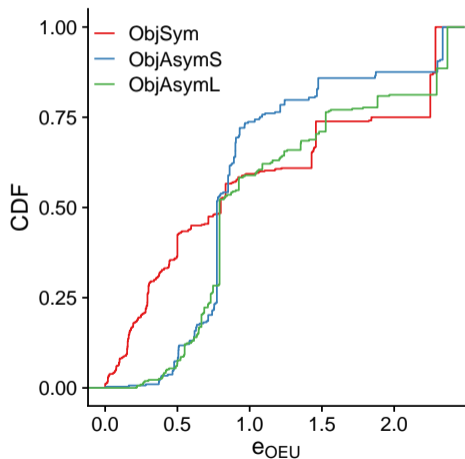
● Measure of consistency: CCEI



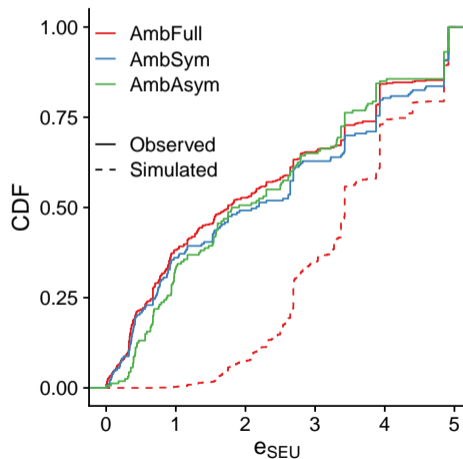
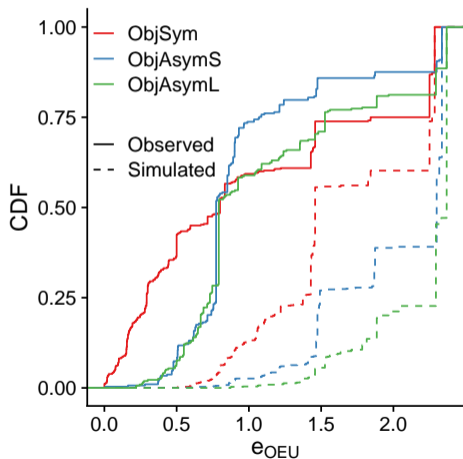
- Measure of consistency: Minimal e

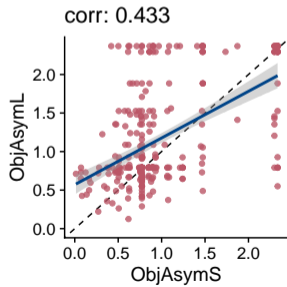
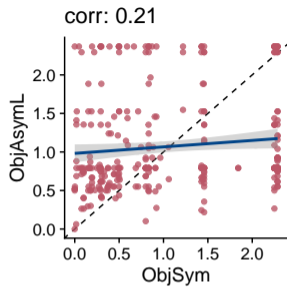
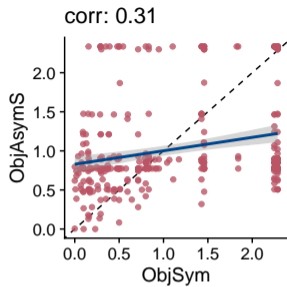


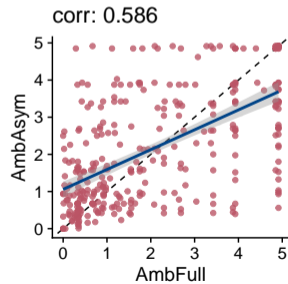
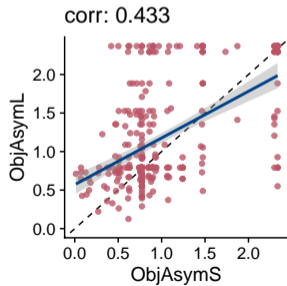
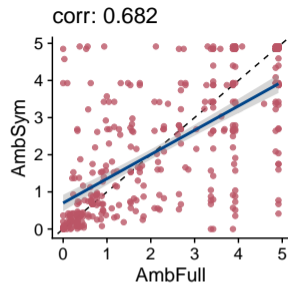
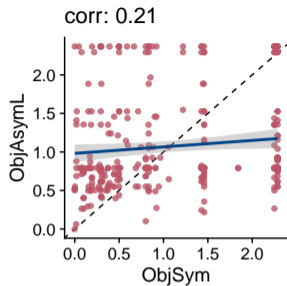
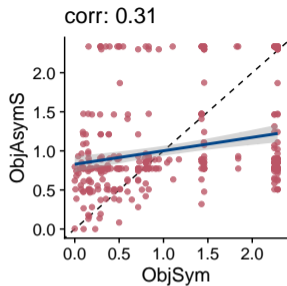
- Measure of consistency: Minimal e



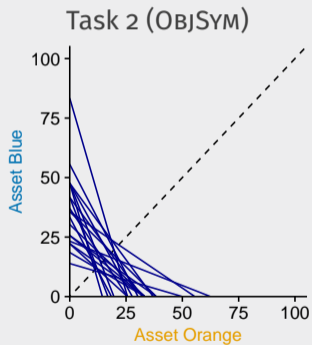
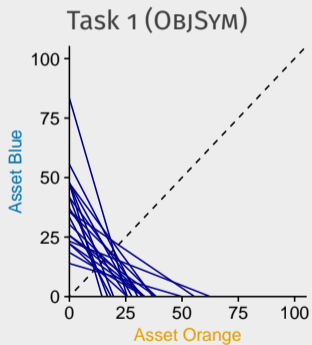
- Measure of consistency: Minimal e

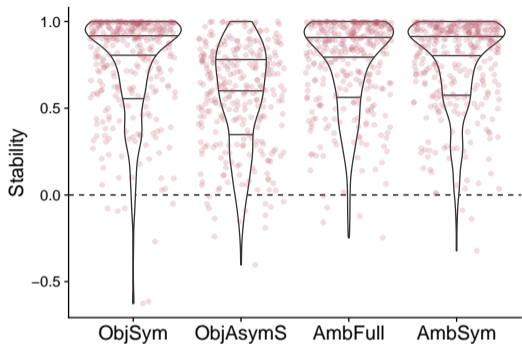




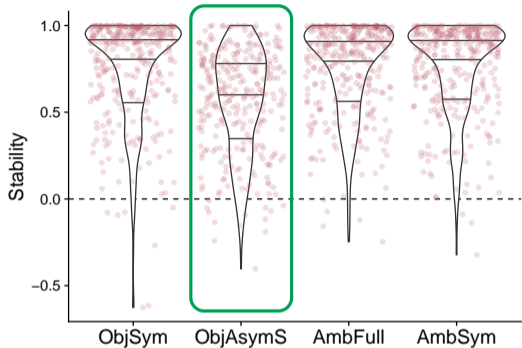


Study 2: Stability of preferences

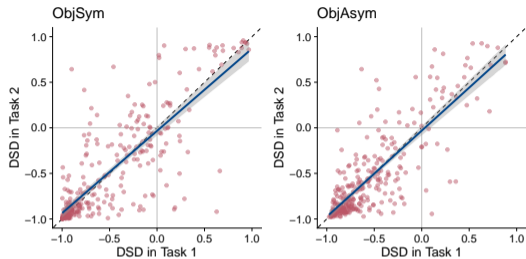
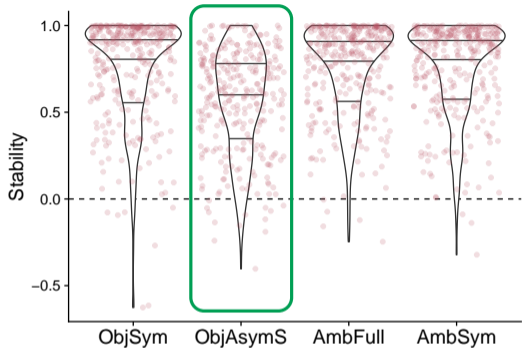




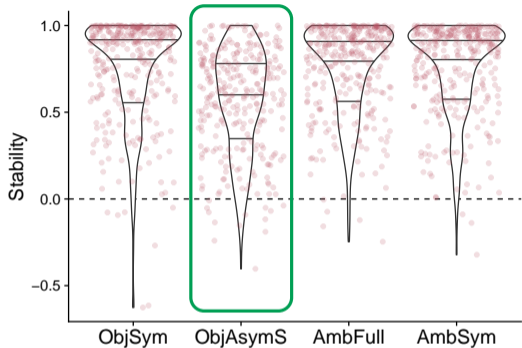
- High correlation between choices made in two tasks



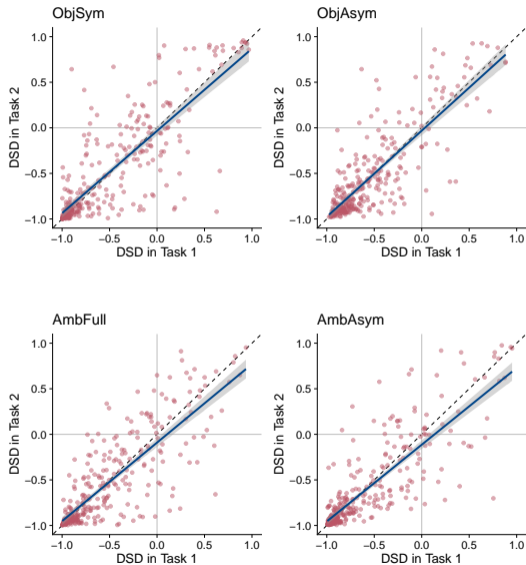
- High correlation between choices made in two tasks
... except for ObjAsym

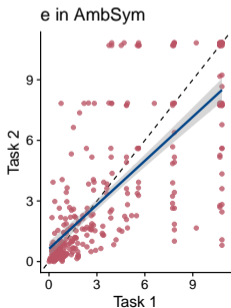
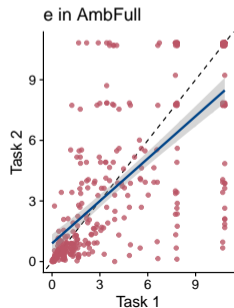
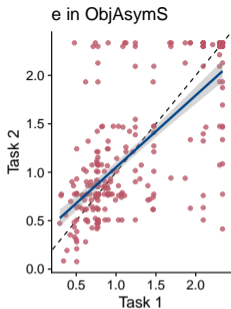
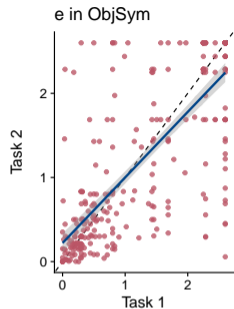


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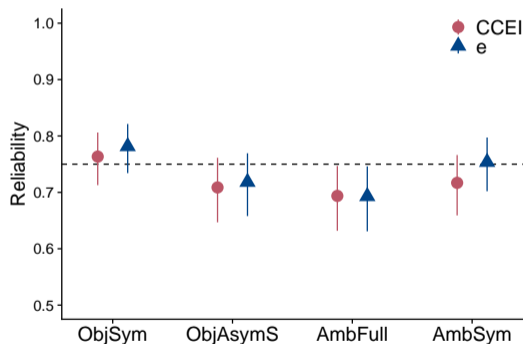


- High correlation between choices made in two tasks
... except for ObjAsym





- High correlation between e from two tasks



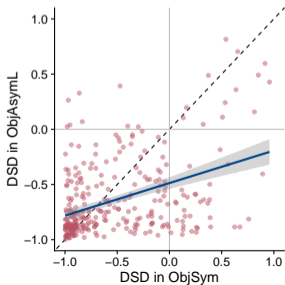
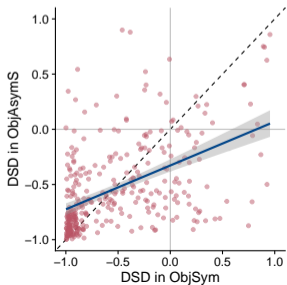
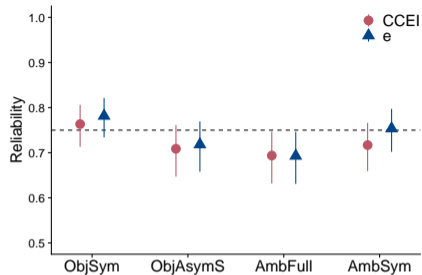
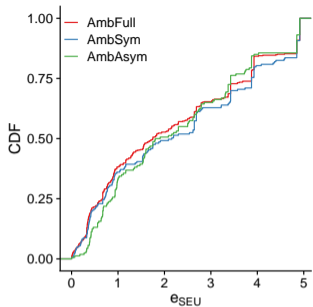
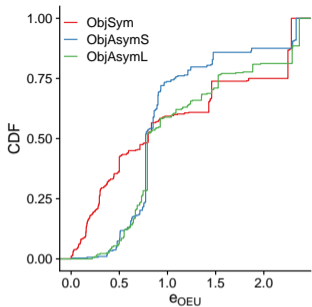
1. Do choices individuals make satisfy RP axioms?
... and how are they influenced by the environment?
2. To what extent are choices consistent with theories of U max?
... and how are they influenced by the environment?
3. Are preferences stable? Are measures of consistency reliable?

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- Across tasks
 - participants responded to asymmetry
 - OBJSYM and AMBFULL were treated similarly
- Within task
 - stable choice patterns



 Comments / Questions

 fede@econ.berkeley.edu