EDGE & ENDOWMENT INSENSITIVITY IN BET SIZING

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with **JASON DANA (YALE),**
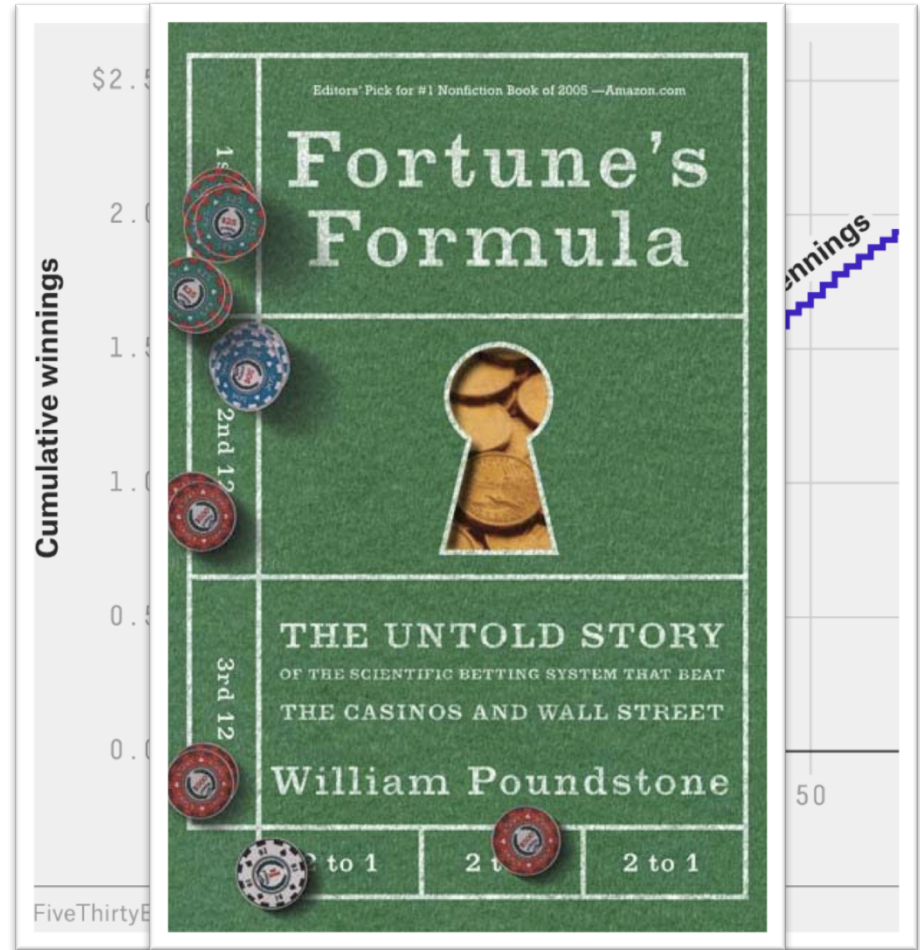**PHILIP TETLOCK (PENN), BARBARA MELLERS (PENN)**

JDM
NOV 15, 2019

HOW MUCH WOULD YOU BET?

You have $100 to invest in each of two gambles.

1. Double-or-nothing bet, coin weighted 55% toward Heads.

2. Double-or-nothing bet, coin weighted 60% toward Heads.

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BET SIZING: THE EASY PART?

RELATED WORK

Coin flip task,
Haghani & Dewey (2016)

People who know what the
Kelly criterion is...

People doing behavioral
studies on gambling...

Newsvendor problem, e.g.
Schweitzer & Cachon, 2000)

Prediction market behavior,
Atanasov et al. (2014)

KELLY PRESCRIPTIONS

$$f = edge / odds$$

1. Size bets in proportion to edge.
   - Naïf: "Double-or-nothing prospect pays 55% of the time."
   - Kelly: "Prospect offers +0.1 edge."

2. Think of bets in proportion to endowment.
   - Naïf: "I have $100. I will bet $10."
   - Kelly: "I will bet 10% of my endowment."

Equivalent to log utility maximization, optimizes long-run growth.

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TASK: COIN FLIPS WITH VARYING EDGE(1)

Play

Probability of Heads: 70%

Bet amount (in cents):

[   ]

[Bet Heads] [Bet Tails]

Balance

$0.23

Time left: 00:09:17

Number of rounds left: 93

History

Counter	Bet	Result	Won/Lost	Amount	Balance
7	Heads	Heads	Won	$0.04	$0.23
6	Heads	Tails	Lost	$0.01	$0.19
5	Heads	Heads	Won	$0.02	$0.20
4	Heads	Tails	Lost	$0.10	$0.18
3	Heads	Tails	Lost	$0.12	$0.28
2	Heads	Tails	Lost	$0.20	$0.40
1	Heads	Heads	Won	$0.10	$0.60

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Try it with play money: **http://coinflipcasino.azurewebsites.net/**
Contact **pavel@pytho.io** about using this task.

COIN FLIPS WITH VARYING EDGE, TIPS (2)

Play

Probability of Heads: **70%**

Tip: Bet $0.09 on Heads.

Bet amount (in cents):

[Bet Heads] [Bet Tails]

Balance

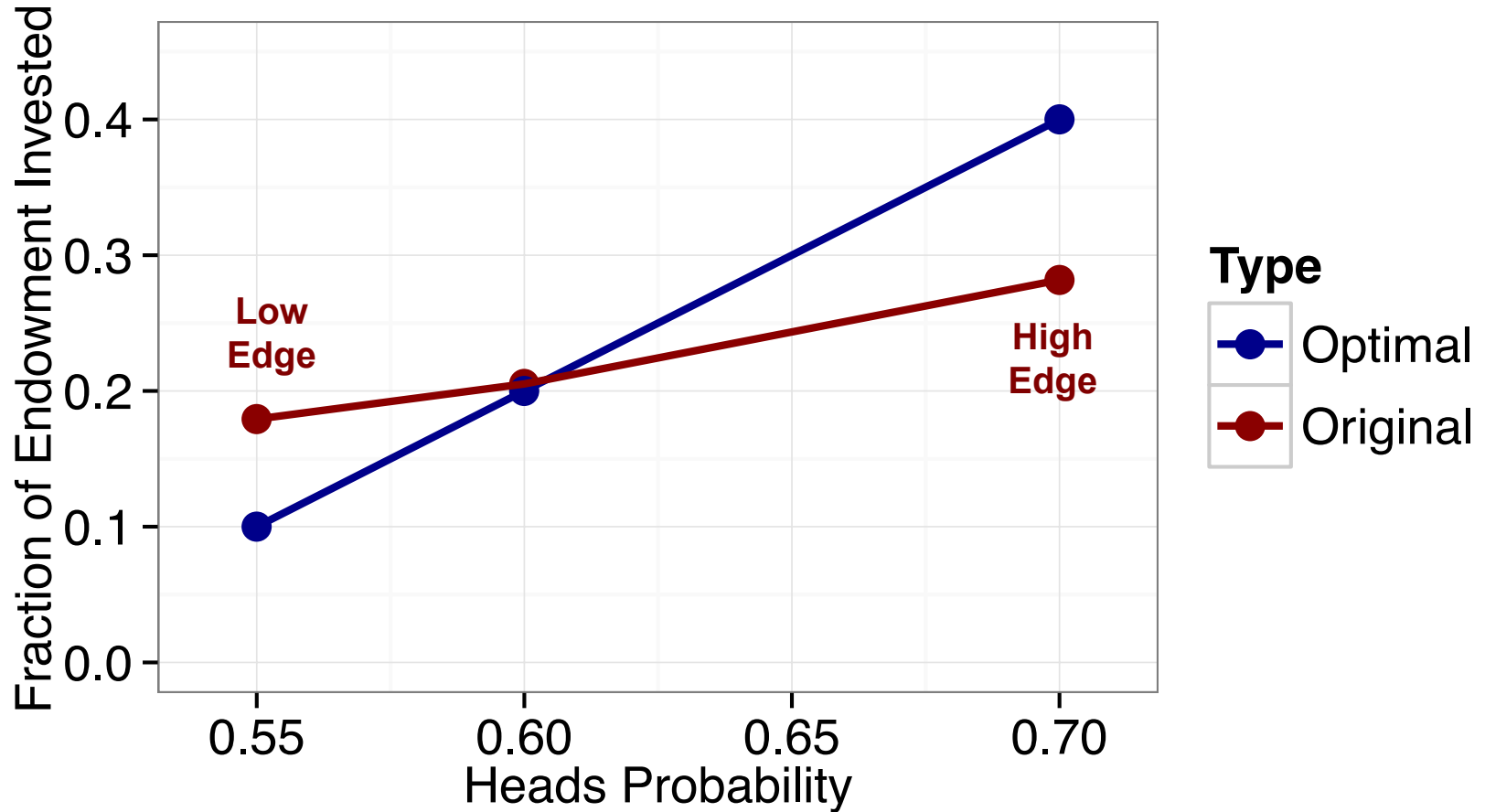**$0.23**

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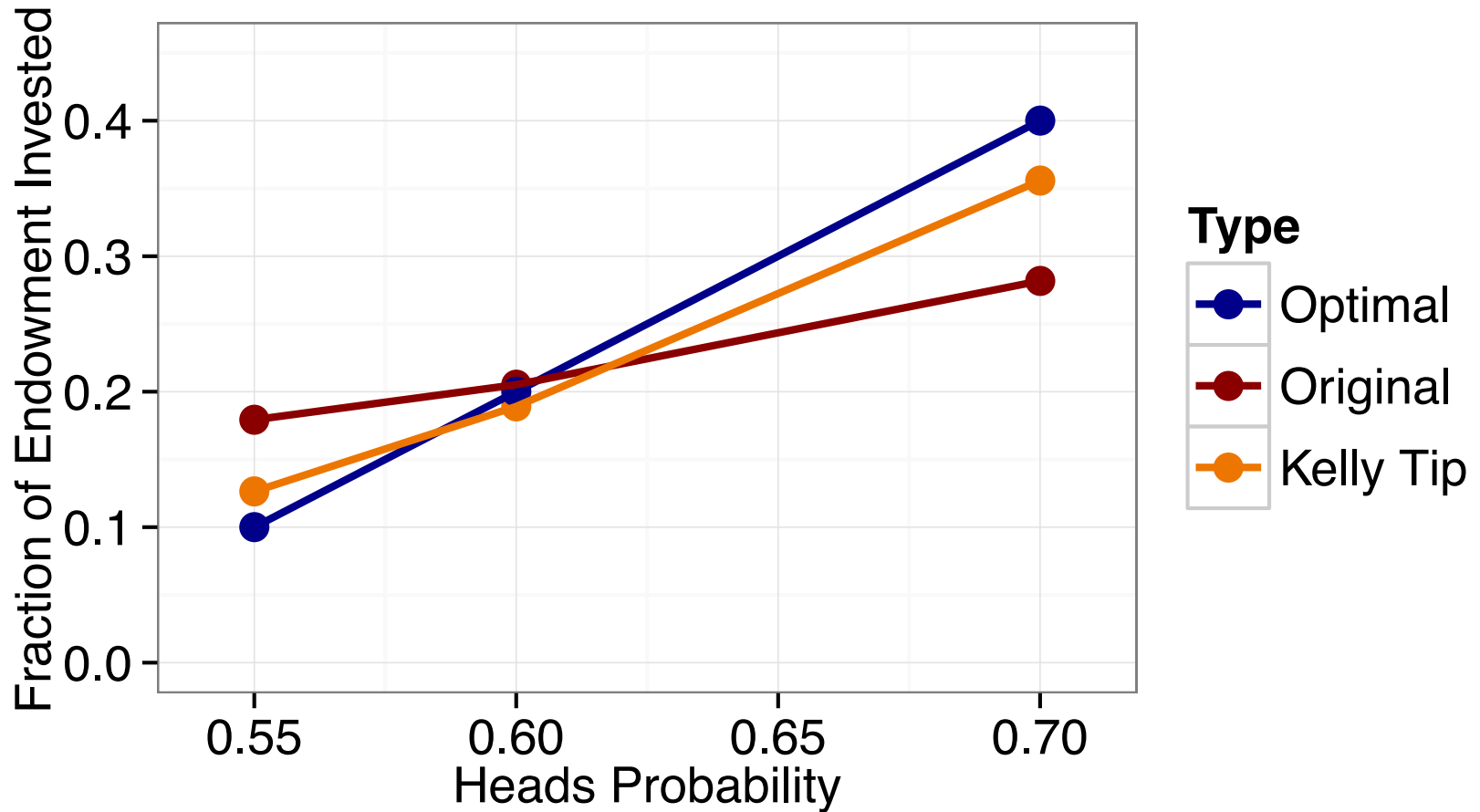Contact **pavel@pytho.io** about using this task.
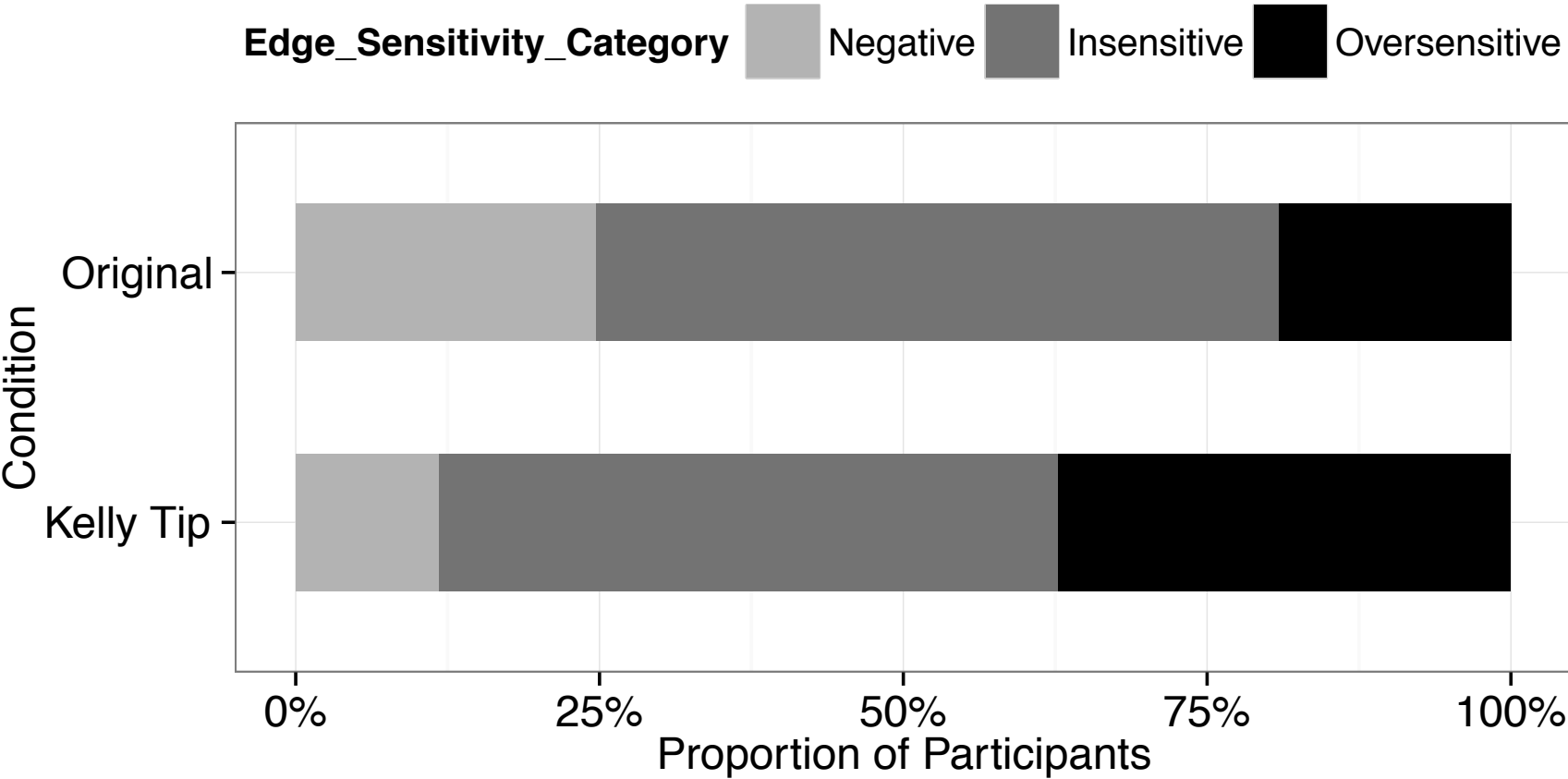
RESULT: EDGE INSENSITIVITY

MAPPING TO HOLT & LAURY (2002)

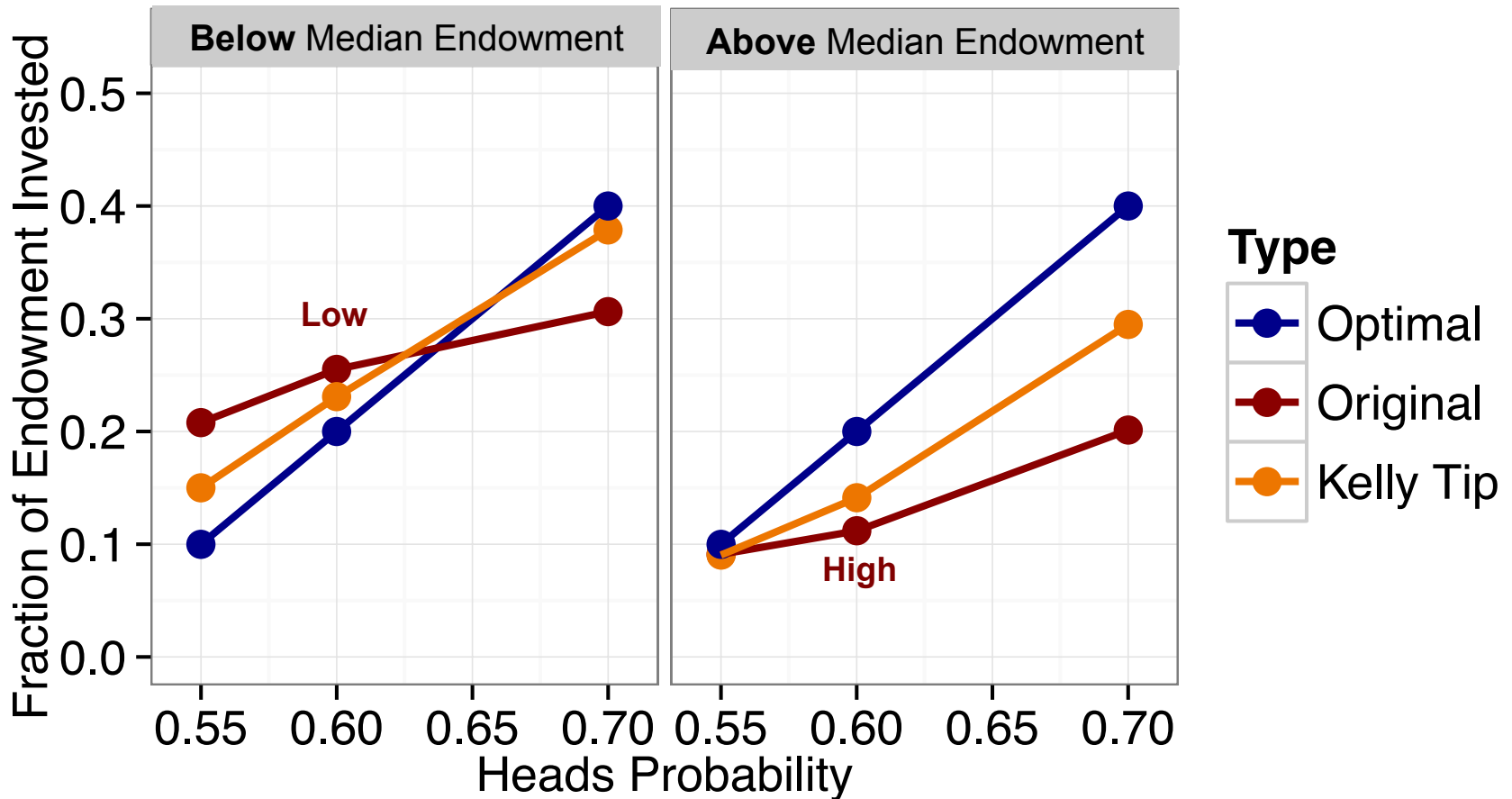| Number of Safe Choices	Range of Relative Risk Aversion for $U(x) = x^{1-r}/(1-r)$		Risk Preference Classification
0-1	$r < -0.95$		highly risk loving
2	$-0.95 < r < -0.49$		very risk loving
3	$-0.49 < r < -0.15$		risk loving
4	$-0.15 < r < 0.15$		risk neutral
5	$0.15 < r < 0.41$		slightly risk averse
6	$0.41 < r < 0.68$	**Low Edge**	risk averse
7	$0.68 < r < 0.97$		very risk averse
8	$0.97 < r < 1.37$		highly risk averse
9-10	$1.37 < r$	**High Edge**	stay in bed

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KELLY TIPS DO NOT ELIMINATE BIAS

EDGE SENSITIVITY DISTRIBUTION

MEAN INVESTMENT SHARE BY ENDOWMENT SIZE

MAPPING TO HOLT & LAURY (2002)

Number of Safe Choices	Range of Relative Risk Aversion for $U(x) = x^{1-r}/(1-r)$	Risk Preference Classification
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4	$-0.15 < r < 0.15$	risk neutral
5	$0.15 < r < 0.41$	slightly risk averse
6	$0.41 < r < 0.68$ **Low**	risk averse
7	$0.68 < r < 0.97$	very risk averse
8	$0.97 < r < 1.37$ **High**	highly risk averse
9-10	$1.37 < r$	stay in bed

EDGE AND ENDOWMENT SENSITIVITY: INFERENTIAL TESTS

	Condition: Original		Condition: Kelly Tip	
	Raw	**Adjusted**	**Raw**	**Adjusted**
Intercept	0.28 (0.02)	0.78 (0.21)	0.12 (0.01)	-0.29 (0.53)
Edge Sensitivity	0.24 (0.01)**	0.15 (0.08)	0.68 (0.02)**	0.64 (0.06)**
Endowment	-0.04 (0.001)**	-0.05 (0.009)**	-0.03 (0.001)**	-0.02 (0.006)**
N Subjects	103	96	109	106
N Subjects×Rounds	6,148	6,055	5,638	5,532
Subject Fixed Effects	Yes	Yes	Yes	Yes

Notes: Linear Mixed Effects Model in R, nlme.
Edge coefficients below 1 denote edge insensitivity.
Standard errors in parentheses.
Cumulative proportion of "Heads" was negatively related to bet fraction, orthogonal to main results.

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UNDERAPPRECIATION OF PROFIT DIFFERENTIALS

On average, how much more profitable will a bet on heads be when the chance of heads is 60% than when it is 55%?
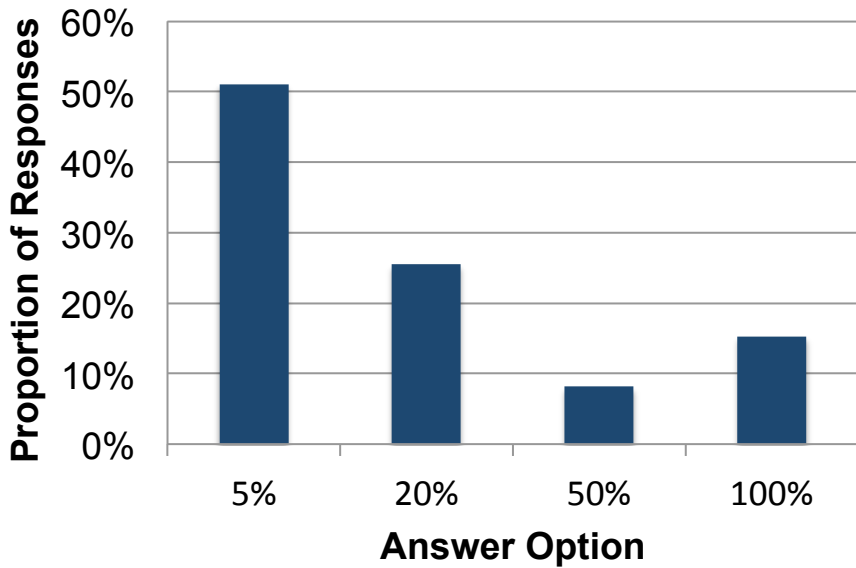
On average, how much more profitable will a bet on heads be when the chance of heads is 70% than when it is 55%?

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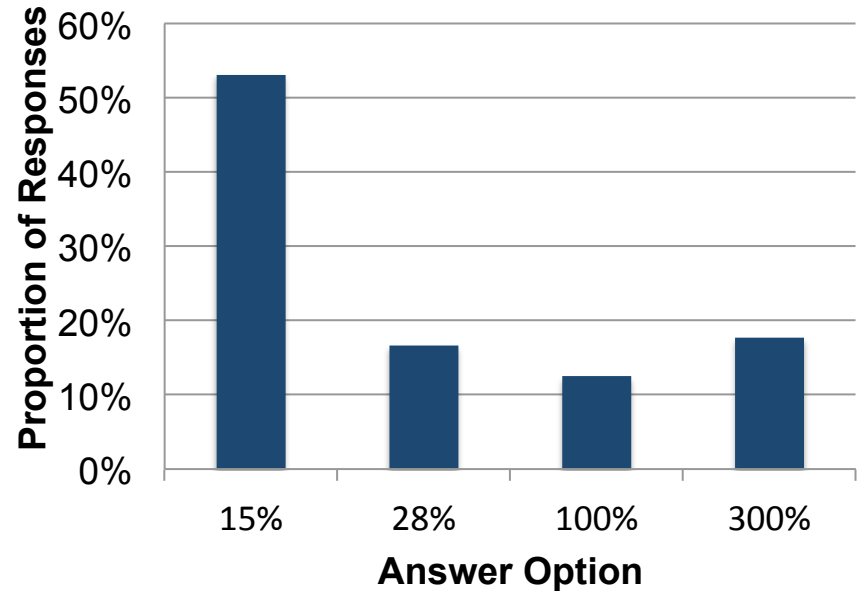
RESULTS SUMMARY

Edge insensitivity:

- Bet sizes are insufficiently responsive to edge

- Violates EUT, goes against loss aversion

- Probability weighting could account for less than half of the effect

Endowment insensitivity:

- Bets sizes are insufficiently responsive to endowment size

- Equates to steeply increasing relative risk aversion

Debiasing: Strong intervention reduced, but did not eliminate effects

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IMPLICATIONS

Edge and **endowment insensitivity** imply that…

- Risk preferences in continuous bets are highly unstable

- Prediction market prices do not reflect average beliefs

- Newsvendor behavior can be suboptimal without demand chasing

- Holzhauer will dominate Jeopardy! $$$ tables if given more chances

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QUESTIONS?

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