Correlation Neglect in Student-to-School Matching

Alex Rees-Jones, Ran Shorrer, and Chloe Tergiman

NBER SI 2020

Introduction

People struggle with reasoning about correlated outcomes.

Econ: Enke and Zimmermann (2019); Eyster and Weizsäcker (2016), many more...

Psych: Reviewed in Hansson, Juslin, and Winman (2008).

Introduction

People struggle with reasoning about correlated outcomes.

> Econ: Enke and Zimmermann (2019); Eyster and Weizsäcker (2016), many more...
>
> Psych: Reviewed in Hansson, Juslin, and Winman (2008).

Key finding in literature: many experimental subjects treat correlated outcomes as if they were independent.

Introduction

People struggle with reasoning about correlated outcomes.

> Econ: Enke and Zimmermann (2019); Eyster and Weizsäcker (2016), many more...
>
> Psych: Reviewed in Hansson, Juslin, and Winman (2008).

Key finding in literature: many experimental subjects treat correlated outcomes as if they were independent.

Goal in this project: Study this behavior, and its consequences, in domains of school choice.

A simple example with correlated admissions

There are three schools to consider. You can apply to two.

Admissions based on a single, random priority number.

- Drawn from Uniform[0,100].

School	Utility	Admission Requirement
The good one (A)	3	50
The middle one (B)	2	45
The bad one (C)	1	0

$A \succ B$ **Aggressive Strategy**

$A \succ C$ **Diversified Strategy**

A simple example with correlated admissions

There are three schools to consider. You can apply to two.

Admissions based on a single, random priority number.

- Drawn from Uniform[0,100].

School	Utility	Admission Requirement
The good one (A)	3	50
The middle one (B)	2	45
The bad one (C)	1	0

$A \succ B$ **Aggressive Strategy** $\rightarrow (\boldsymbol{A}, 50\%; \boldsymbol{B}, 5\%; \emptyset, 45\%)$

$A \succ C$ **Diversified Strategy** $\rightarrow (\boldsymbol{A}, 50\%; \boldsymbol{C}, 50\%)$

A simple example with uncorrelated admissions

There are three schools to consider. You can apply to two.

Admissions based on school-specific, random priority numbers.

- Each independently drawn from Uniform[0,100].

School	Utility	Admission Requirement
The good one (A)	3	50
The middle one (B)	2	90
The bad one (C)	1	0

$A \succ B$ **Aggressive Strategy**

$A \succ C$ **Diversified Strategy**

A simple example with uncorrelated admissions

There are three schools to consider. You can apply to two.

Admissions based on school-specific, random priority numbers.

- Each independently drawn from Uniform[0,100].

School	Utility	Admission Requirement
The good one (A)	3	50
The middle one (B)	2	90
The bad one (C)	1	0

$A \succ B$ **Aggressive Strategy** $\rightarrow (\boldsymbol{A}, 50\%; \boldsymbol{B}, 5\%; \emptyset, 45\%)$

$A \succ C$ **Diversified Strategy** $\rightarrow (\boldsymbol{A}, 50\%; \boldsymbol{C}, 50\%)$

This project

We conduct a lab experiment with incentivized pairs of scenarios like the one already considered.

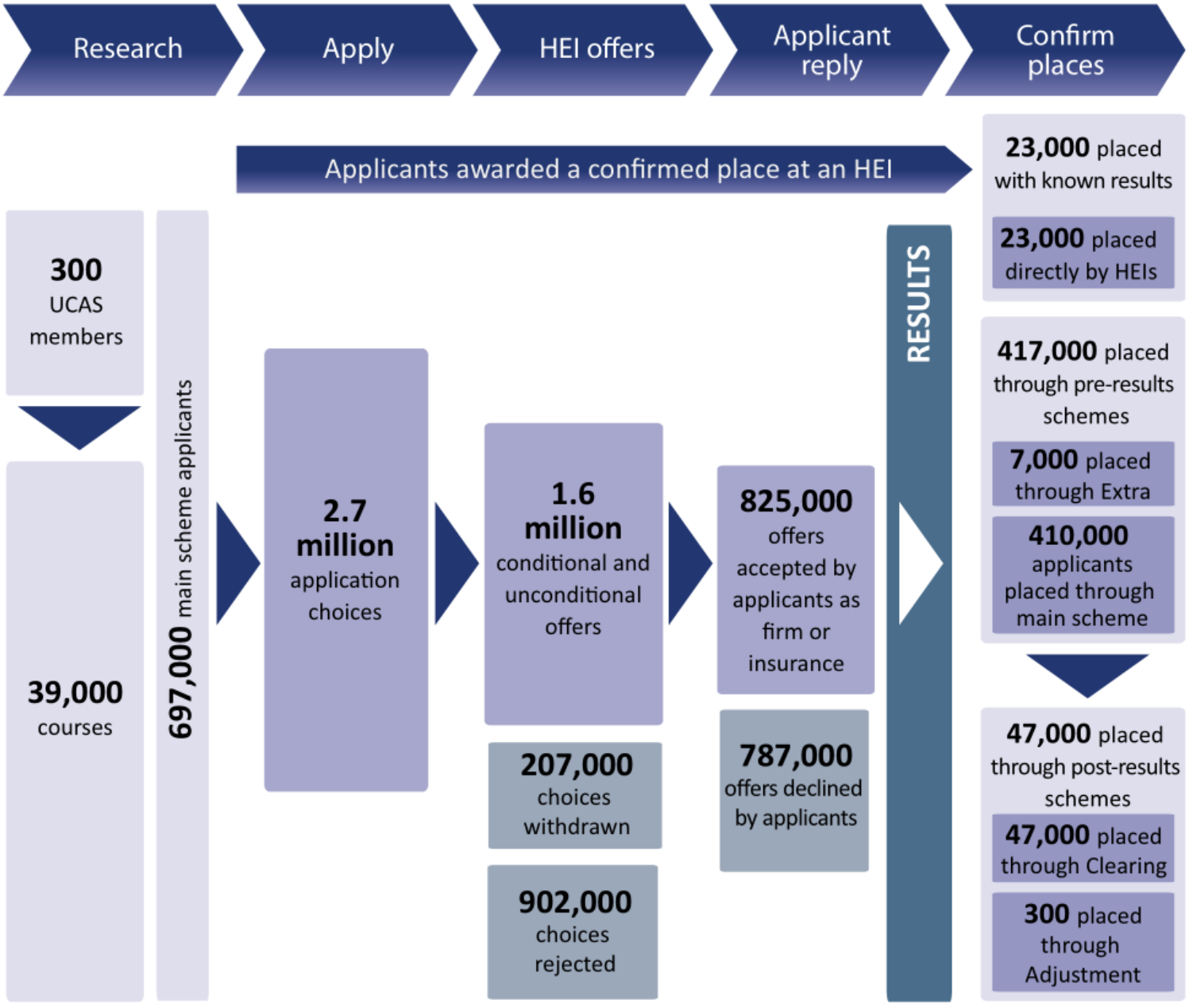
Findings:

- Within "matched pair" scenarios, choices vary depending on experimentally manipulated presence or absence of correlation.
  - With correlated admissions, "safety" options neglected.
  - Both within-subject and between-subjects.
- Choices in the presence of correlation are suspect.
  1. Analytically unwise.
  2. Patterns match our theoretical prediction on correlation-neglectful agents
  3. Inconsistent with transparent choice.
  4. Within-subject preference reversals predicted by Enke-Zimmermann measure of correlation neglect.

Scenarios more "real" than they may seem

Correlated example closely mirrors several national matches.

- United Kingdom: The Universities and Colleges Admissions Service (UCAS).
- Ghana: Computerized School Selection and Placement System (CSSPS).
  - Ajayi (2013).
- Kenya: Secondary School Admissions.
  - Lucas and Mbiti (2012).



Source: UCAS (2011)

Do you also want to select an insurance choice (Optional)?

Note:

Your Insurance choice is a second choice and it should be used as a backup. You will ONLY get the opportunity to attend if you are not accepted on your firm choice AND you meet the conditions of your insturance choice.

You don't have to have an insurance choice. Please only choose one if you want to make this commitment.

The conditions for your insurance choice should be less than those required by your firm choice, as this will increase your chances of being accepted on a course should you not meet the conditions set by your firm choice.

Brighton and Sussex Medical School B74

Medicine A100

Start date: 1 Sep 2016
Start from: Year One

The university or college has offered you an unconditional place.

(Unconditional offer)

Show details of offer

Make this my insurance choice

The University of Birmingham B32

The university or college has offered you a place subject to

Correlated example closely mirrors several national matches.

- United Kingdom: The Universities and Colleges Admissions Service (UCAS).
- Ghana: Computerized School Selection and Placement System (CSSPS).
  - Ajayi (2013).
- Kenya: Secondary School Admissions.
  - Lucas and Mbiti (2012).

Key features of all examples:

- Small set of apps. sent before test results known.
- Test results will introduce correlation in admissions decisions.
- Some evidence suggesting bad decision-making.
  - Key flag: second choice more selective than the first.

Theory (summary)

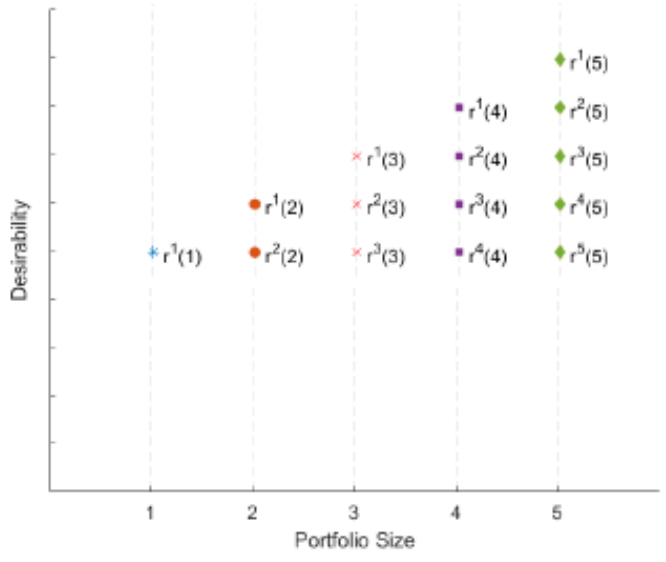
Consequences of neglect:

1. **Optimism** about the experienced utility from any rank-order list (ROL)
2. **Aggression** and thus higher probability of failure to match

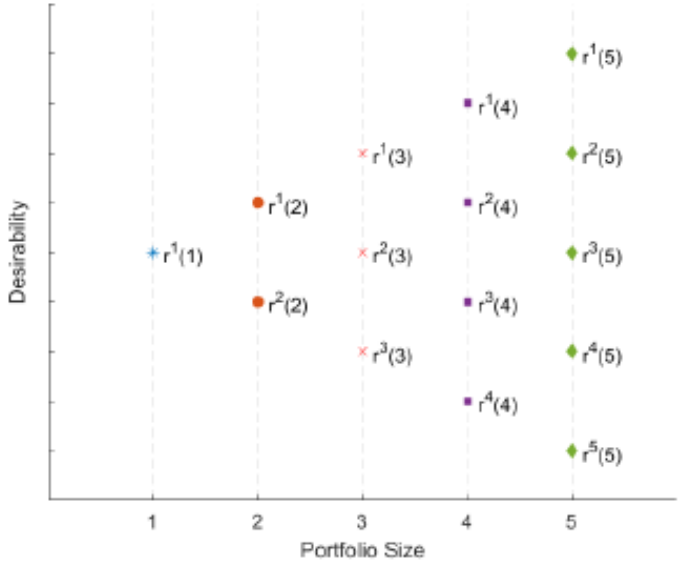
Note: utility loss from correlation neglect can be substantial.

- Worst case bound: sophisticated agent gets k times the utility of the neglectful agent, where k is the permitted ROL length.
- In presence of close substitutes, neglectful agent may be about as well off as if he had a single application.

Optimal portfolios with and without correlation



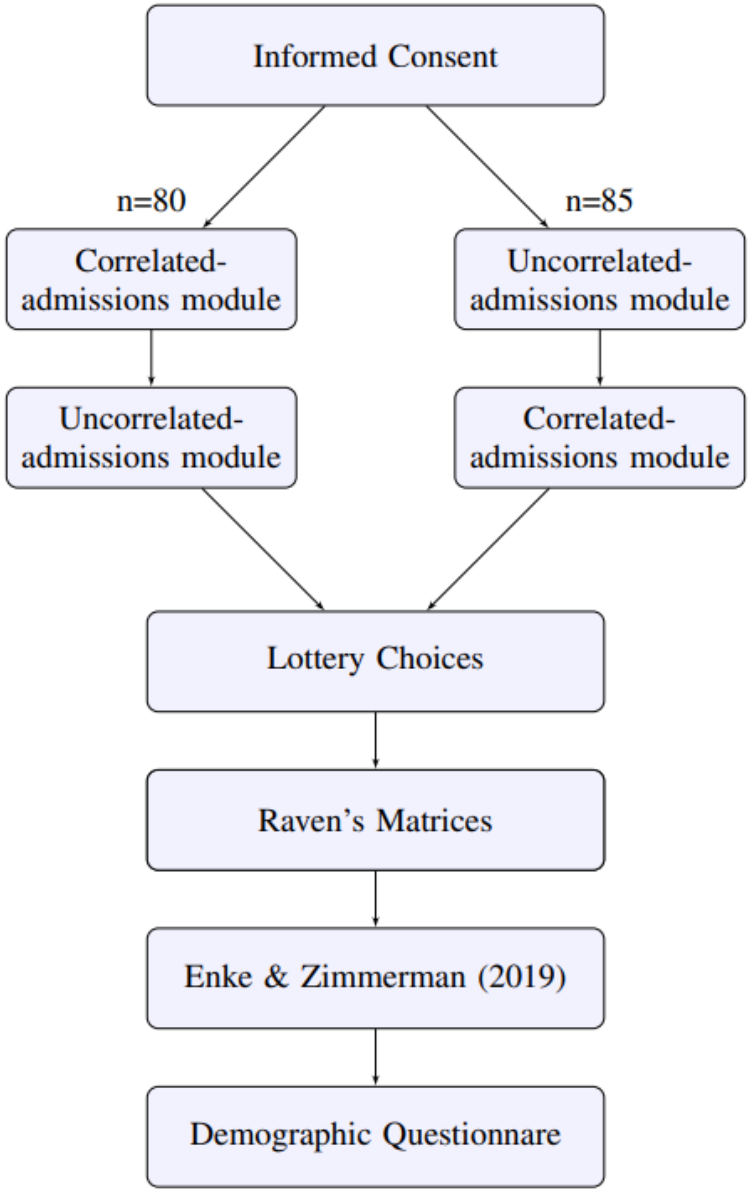
Independent admissions chances



Perfectly aligned admissions chances

https://www.youtube.com/watch?v=fod7xWxROjE

Experimental design



Timeframe: January and February 2019.

Location: Penn State Laboratory for Economics, Management, and Auctions (LEMA).

Sample size: 165.

Average earnings: \$18.10.

Preregistered on aspredicted.org.

Constructing scenarios

Beyond baseline scenario, we included variants that:

- Make "safety" option uncertain.
- Make aggressive strategy have higher EV.
- Have middle program with higher req. than good program.
- Introduce some rationale for pursuing $B \succ C$.

School	Payouts	Admission Requirement
The good one (A)	\$10	50
The middle one (B)	\$5	45/90
The bad one (C)	\$2.5	0

Constructing scenarios

Beyond baseline scenario, we included variants that:

- Make "safety" option uncertain.
- Make aggressive strategy have higher EV.
- Have middle program with higher req. than good program.
- Introduce some rationale for pursuing $B \succ C$.

School	Payouts	Admission Requirement
The good one (A)	\$10	50
The middle one (B)	\$5	45/90
The bad one (C)	\$2.5	10/20

Constructing scenarios

Beyond baseline scenario, we included variants that:

- Make "safety" option uncertain.
- Make aggressive strategy have higher EV.
- Have middle program with higher req. than good program.
- Introduce some rationale for pursuing $B \succ C$.

School	Payouts	Admission Requirement
The good one (A)	\$10	50
The middle one (B)	\$5	20/40
The bad one (C)	\$2.5	0

Constructing scenarios

Beyond baseline scenario, we included variants that:

- Make "safety" option uncertain.
- Make aggressive strategy have higher EV.
- Have middle program with higher req. than good program.
- Introduce some rationale for pursuing $B \succ C$.

School	Payouts	Admission Requirement
The good one (A)	\$10	50
The middle one (B)	\$5	55/100
The bad one (C)	\$2.5	0

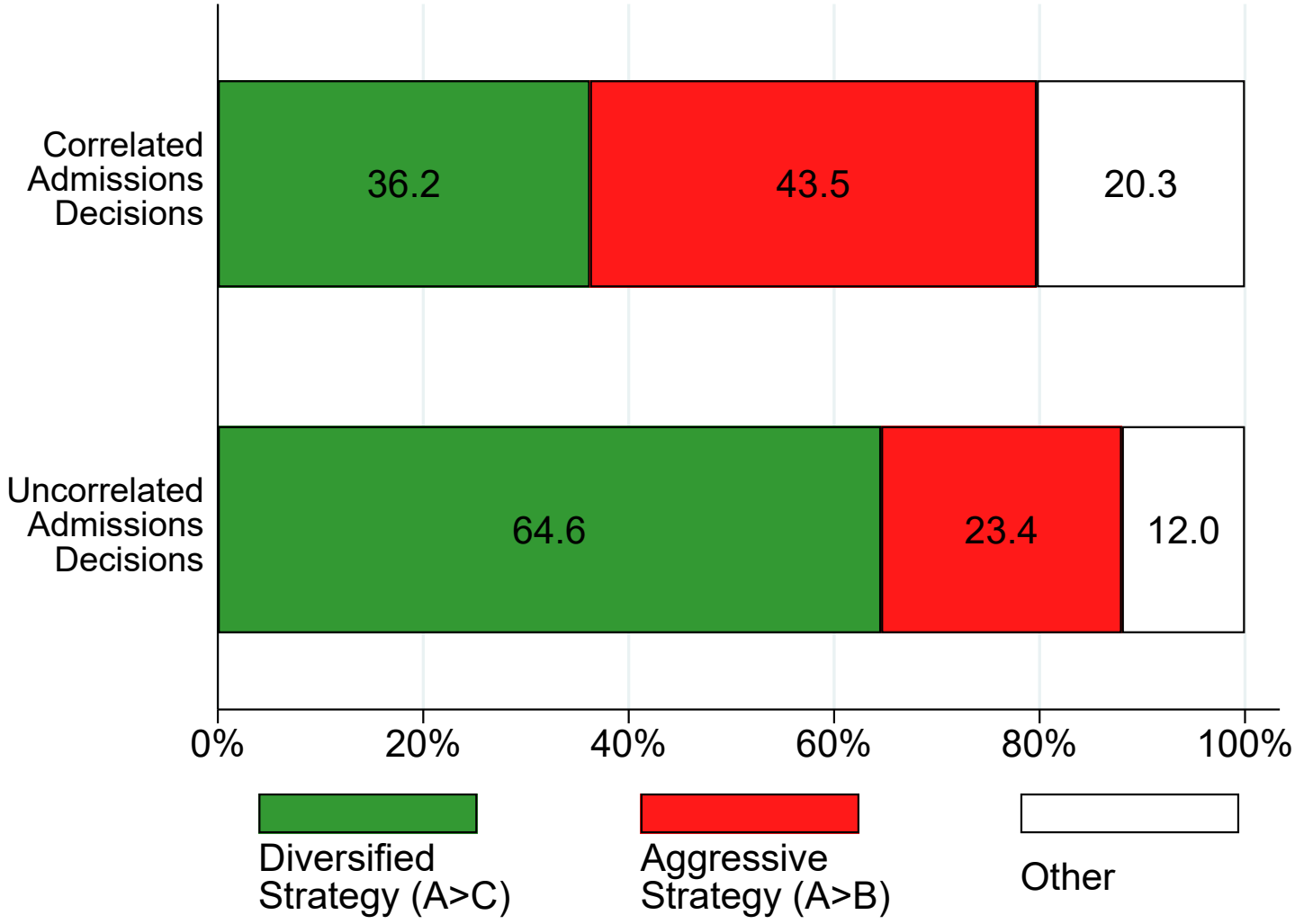
Constructing scenarios

Beyond baseline scenario, we included variants that:

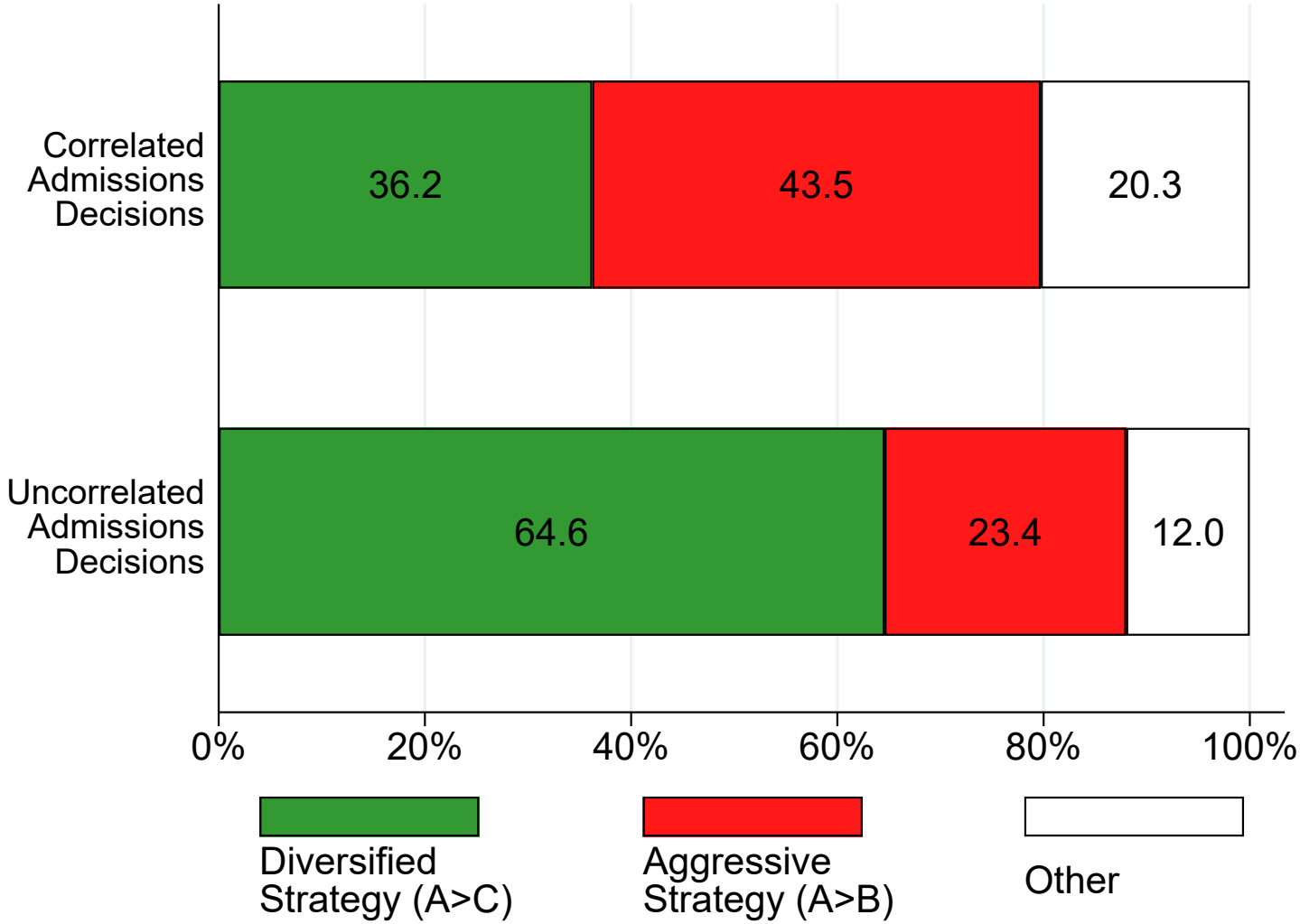
- Make "safety" option uncertain.
- Make aggressive strategy have higher EV.
- Have middle program with higher req. than good program.
- Introduce some rationale for pursuing $B \succ C$.

School	Payouts	Admission Requirement
The good one (A)	\$10	80
The middle one (B)	\$5	60/75
The bad one (C)	\$2.5	0

Application strategies and correlation



Application strategies and correlation



Within-subject: Target preference reversal occurs in 21.1% of subject-scenarios. Opposite reversal never exceeds 6%.

Scenario		Rank-Order List $(A \succ B)$	$(A \succ C)$	$(B \succ C)$	Other	Test of Equality (p-values) Full Dist.	$(A \succ B)$	$(A \succ C)$
1.	C: (50, 45, 0)	48.5	44.9	4.2	2.4	0.01**	<0.01***	<0.01***
	U: (50, 90, 0)	10.9	84.2	0.0	4.9			
2.	C: (50, 45, 10)	50.3	44.2	3.0	2.4	<0.01***	<0.01***	<0.01***
	U: (50, 90, 20)	10.3	87.9	0.0	1.8			
3.	C: (50, 20, 0)	74.6	18.8	6.1	0.6	<0.01***	<0.01***	<0.01***
	U: (50, 40, 0)	49.7	40.6	6.1	3.6			
4.	C: (50, 20, 10)	81.8	12.7	4.9	0.6	<0.01***	<0.01***	<0.01***
	U: (50, 40, 20)	67.9	24.9	3.6	3.6			
5.	C: (50, 55, 0)	26.7	69.1	1.2	3.0	<0.01***	<0.01***	<0.01***
	U: (50, 100, 0)	7.9	87.9	0.6	3.6			
6.	C: (75, 60, 0)	24.9	45.4	23.0	6.7	<0.01***	<0.01***	<0.01***
	U: (75, 80, 0)	12.7	76.4	3.6	7.3			
7.	C: (75, 60, 30)	31.3	38.2	25.5	6.0	<0.01***	<0.01***	<0.01***
	U: (75, 80, 40)	14.6	76.4	0.6	8.5			
8.	C: (80, 60, 0)	24.2	29.1	40	6.7	<0.01***	0.03**	<0.01***
	U: (80, 75, 0)	14.5	57.6	18.8	9.1			
9.	C: (80, 60, 40)	30.3	23.6	39.4	6.7	<0.01***	0.10	<0.01***
	U: (80, 75, 50)	22.4	45.5	21.2	10.9			

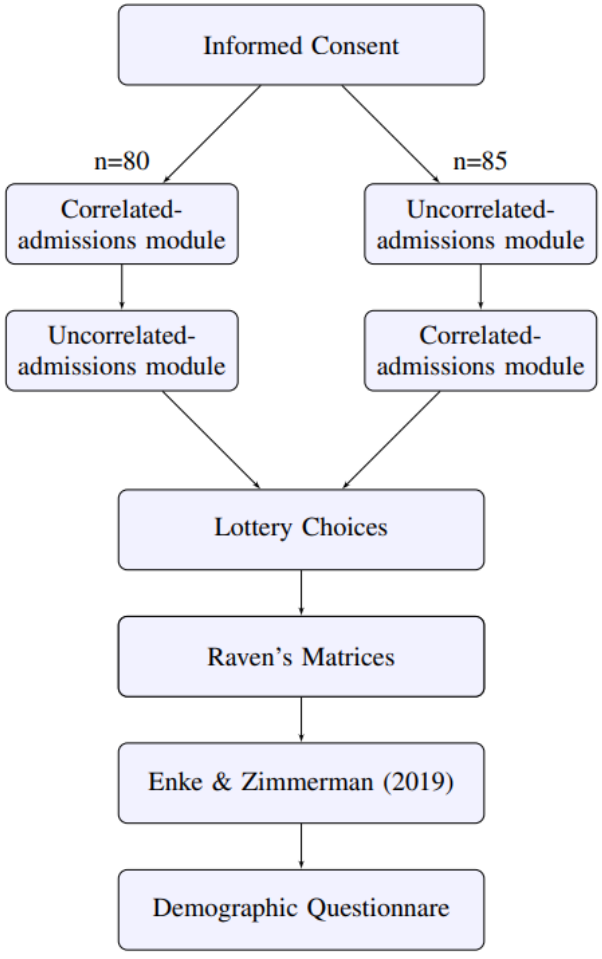
Which choice should we believe?

We have shown that chosen ROLs respond to changes in the frame.

Begs the question: which choice do we believe?

Support that correlated choices are suspect.

1. Analytical wisdom.
2. Patterns match our theoretical prediction on correlation-neglectful agents
3. Choices from transparent gambles.
4. Predictability from CN measure.



Lottery choice: application of Bernheim and Rangel (2009).

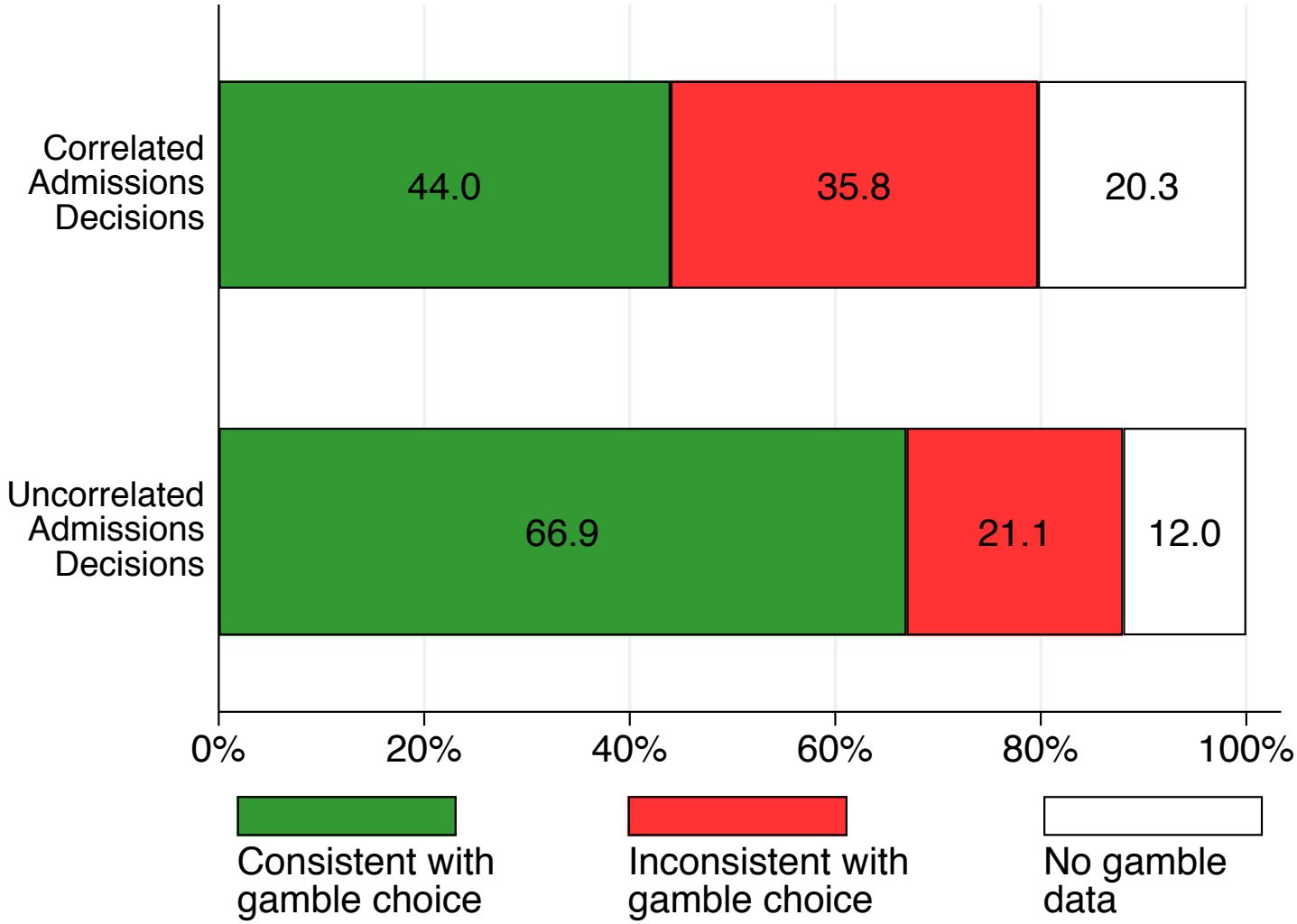
Idea: transparent lottery choice is debiased.

Please select which of the two options below you would prefer to have count for payment:

○ $ 10 with 50% chance
$ 5 with 5% chance
$ 0 with 45% chance

○ $ 10 with 50% chance
$ 2.5 with 40% chance
$ 0 with 10% chance

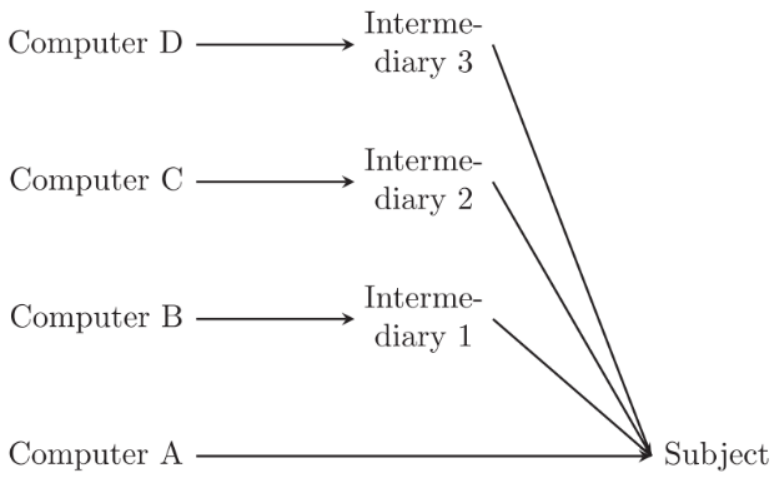
Consistency with gamble choices

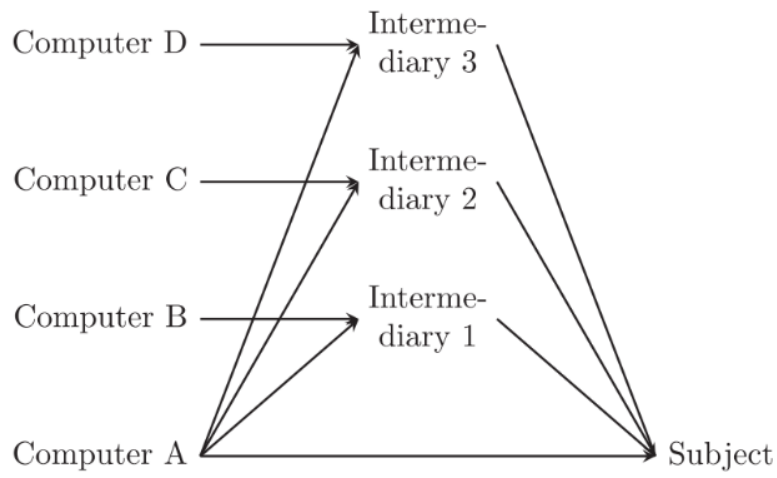


Note: $87 - 98\%$ preferred the gamble induced by $(A \succ C)$.

- Excluding two scenarios where EV of $(A \succ B)$ was greater.

Association with Enke-Zimmermann measure

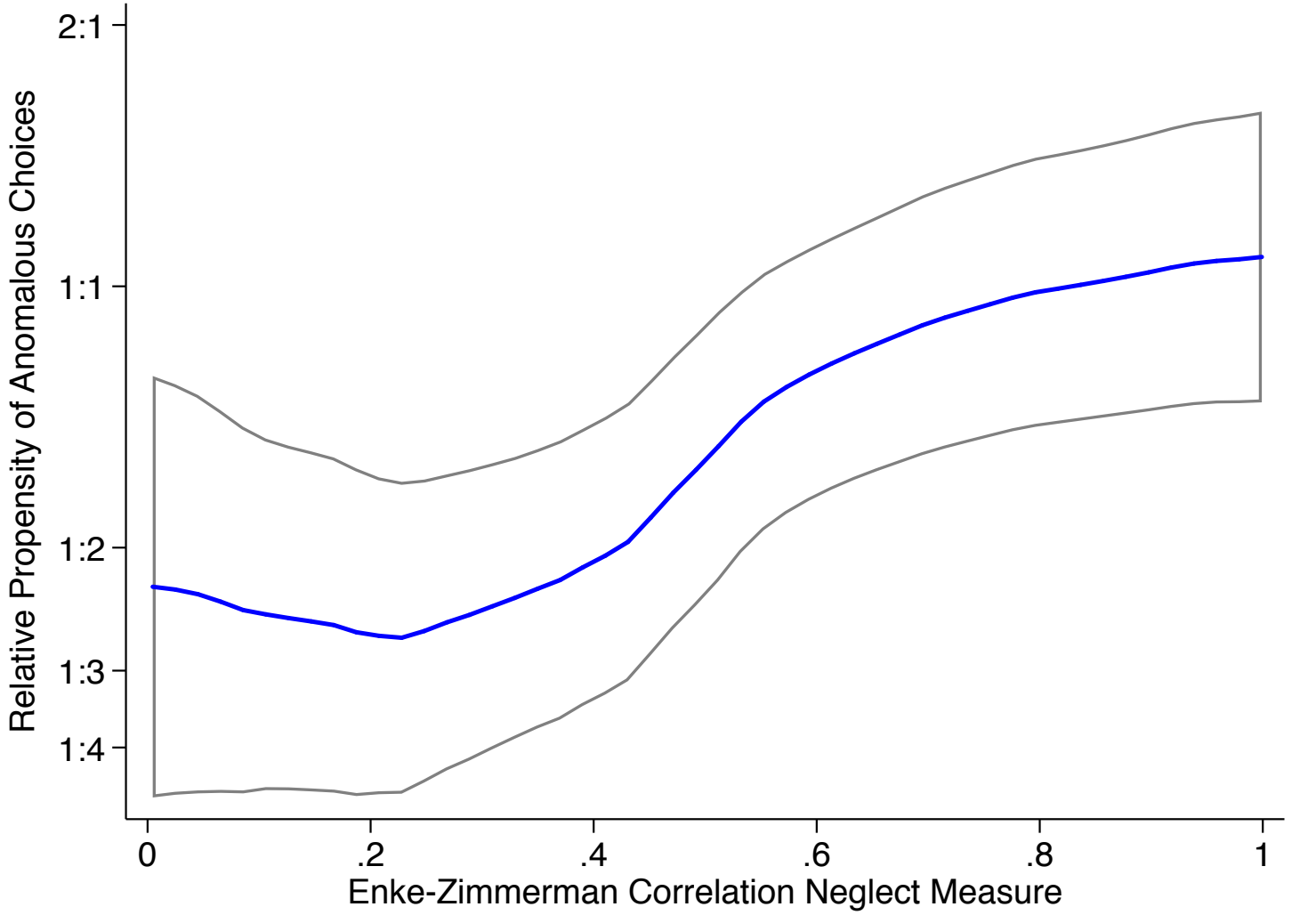




We directly examine the relationship between our preference reversals of interest and the Enke-Zimmermann parameter.

Idea of EZ: See if subjects condition-out common info before averaging four signals.

$$f = \chi f^{\text{naive}} + (1 - \chi) f^{\text{optimal}}$$



Association holds in regressions with and without demo. controls.

- Warning: deviation from preregistration.

	(1)	(2)
Enke-Zimmermann Measure	0.323 (0.120)***	0.263 (0.125)**
EZ Missing	0.212 (0.100)**	0.171 (0.105)
Raven's Matrices Performance		-0.046 (0.025)*
Female		0.036 (0.060)
High School GPA		0.007 (0.042)
College GPA		-0.090 (0.082)
Attended High School in USA		-0.043 (0.099)
Math		0.052 (0.073)
Constant	0.220 (0.090)**	0.751 (0.331)
# of observations	157	157
R^2	0.045	0.080

Conclusion

In our scenarios, students' application decisions suffer under correlation.

Unfortunately, admissions decisions in the world are correlated.

$\rightarrow$ Potential for use of behavioral econ in market design.

Some practical responses:

- Relatively easy "nudges" available.
- Interacts with technical literature on single vs. multiple tie-breaking rules.
  - Single tie-breaking may have efficiency advantages, but might induce worse decisions.
- Can partially protect subjects by forcing diversification.
  - Upside to the Kenyan system?

Real Scenario: You are making a college application decision. There are three colleges accepting applications, listed in the table below.

	Bonus if you enroll	Minimum test score
College A	$ 10	50
College B	$ 5	45
College C	$ 2.5	0

If you apply to a college, they will admit you only if your test score is greater than or equal to the minimum score that they accept. The same test is accepted by all colleges. The test score is randomly generated, and has an equal probability of being any whole number from 0 to 99.

Please indicate your first-choice and your second-choice applications below.

Items
College A
College B
College C

Application List

Lottery question		% chose $(A \succ C)$ in lottery	% chose $(A \succ B)$ in lottery cond. on ROL responding to correlation	% chose $(A \succ C)$ in lottery cond. on $(A \succ C)$ in both ROLs
1.	$(A \succ B)$: \$10 w/50%, \$5 w/5% $(A \succ C)$: \$10 w/50%, \$2.5 w/50%	92.7	9.7	92.7
2.	$(A \succ B)$: \$10 w/50%, \$5 w/5% $(A \succ C)$: \$10 w/50%, \$2.5 w/40%	97.6	1.5	98.6
3.	$(A \succ B)$: \$10 w/50%, \$5 w/30% $(A \succ C)$: \$10 w/50%, \$2.5 w/50%	68.5	21.4	76.2
4.	$(A \succ B)$: \$10 w/50%, \$5 w/30% $(A \succ C)$: \$10 w/50%, \$2.5 w/40%	47.3	62.5	69.2
5.	$(A \succ B)$: \$10 w/50% $(A \succ C)$: \$10 w/50%, \$2.5 w/50%	97.0	5.7	97.2
6.	$(A \succ B)$: \$10 w/25%, \$5 w/15% $(A \succ C)$: \$10 w/25%, \$2.5 w/75%	98.2	0.0	98.6
7.	$(A \succ B)$: \$10 w/25%, \$5 w/15% $(A \succ C)$: \$10 w/25%, \$2.5 w/45%	98.2	6.9	100
8.	$(A \succ B)$: \$10 w/20%, \$5 w/20% $(A \succ C)$: \$10 w/20%, \$2.5 w/80%	97.0	14.3	97.3
9.	$(A \succ B)$: \$10 w/20%, \$5 w/20% $(A \succ C)$: \$10 w/20%, \$2.5 w/40%	88.5	38.9	100