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Evaluating the Welfare of Index Insurance

Joint with Glenn Harrison, Jimmy Martinez-Correa,
and J. Todd Swarthout

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Summary

- Evaluate expected welfare gain of index insurance
  - Take into account individual's risk preferences
- Compound nature of basis risk in index insurance
  - Reduces take-up as well as welfare of individual's insurance choices
- Welfare drivers
  - No significant effect from correlation and premia
  - Significant effect of consistency with ROCL

Overview

- Motivation
  - How are insurance products evaluated
- How do we evaluate welfare (Theory)
  - Index insurance
  - Risk preferences
- Experimental Design
  - Insurance choices
  - Risk lotteries
- Results
- Conclusions

Motivation – Evaluation of Insurance

- Index insurance
  - Basis risk is a compound risk
- Welfare gain
  - Future risky benefits versus certain upfront costs
  - Requires risk preferences
  - Use economic theory to measure welfare
- We run lab experiments to test this
  - Ideal controlled environment
  - Complementary to the field

Methodology

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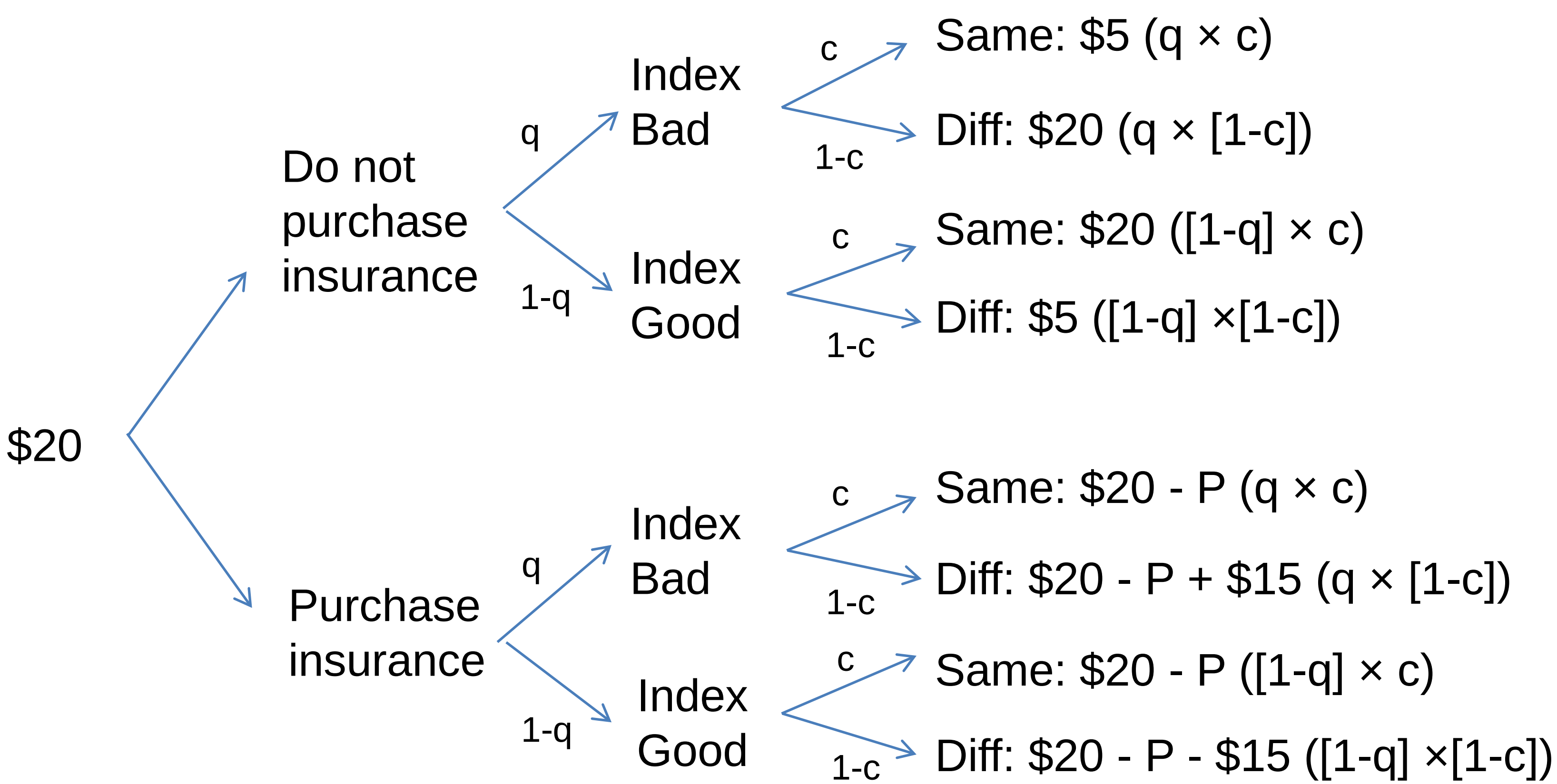
EVALUATING THE EXPECTED WELFARE GAIN FROM INSURANCE

Glenn W. Harrison
Jia Min Ng

Index Insurance



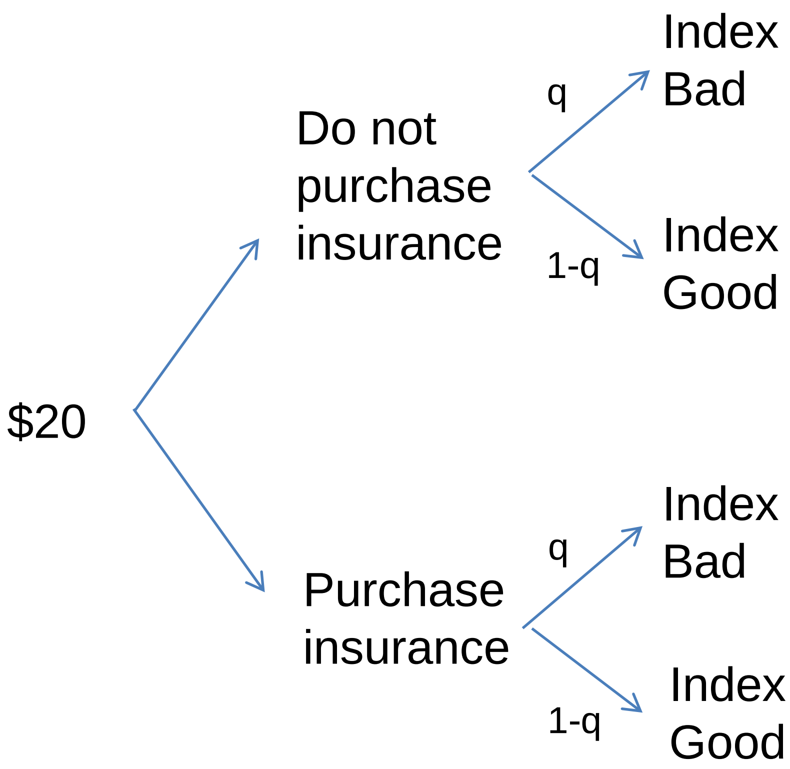
Index Insurance

$20

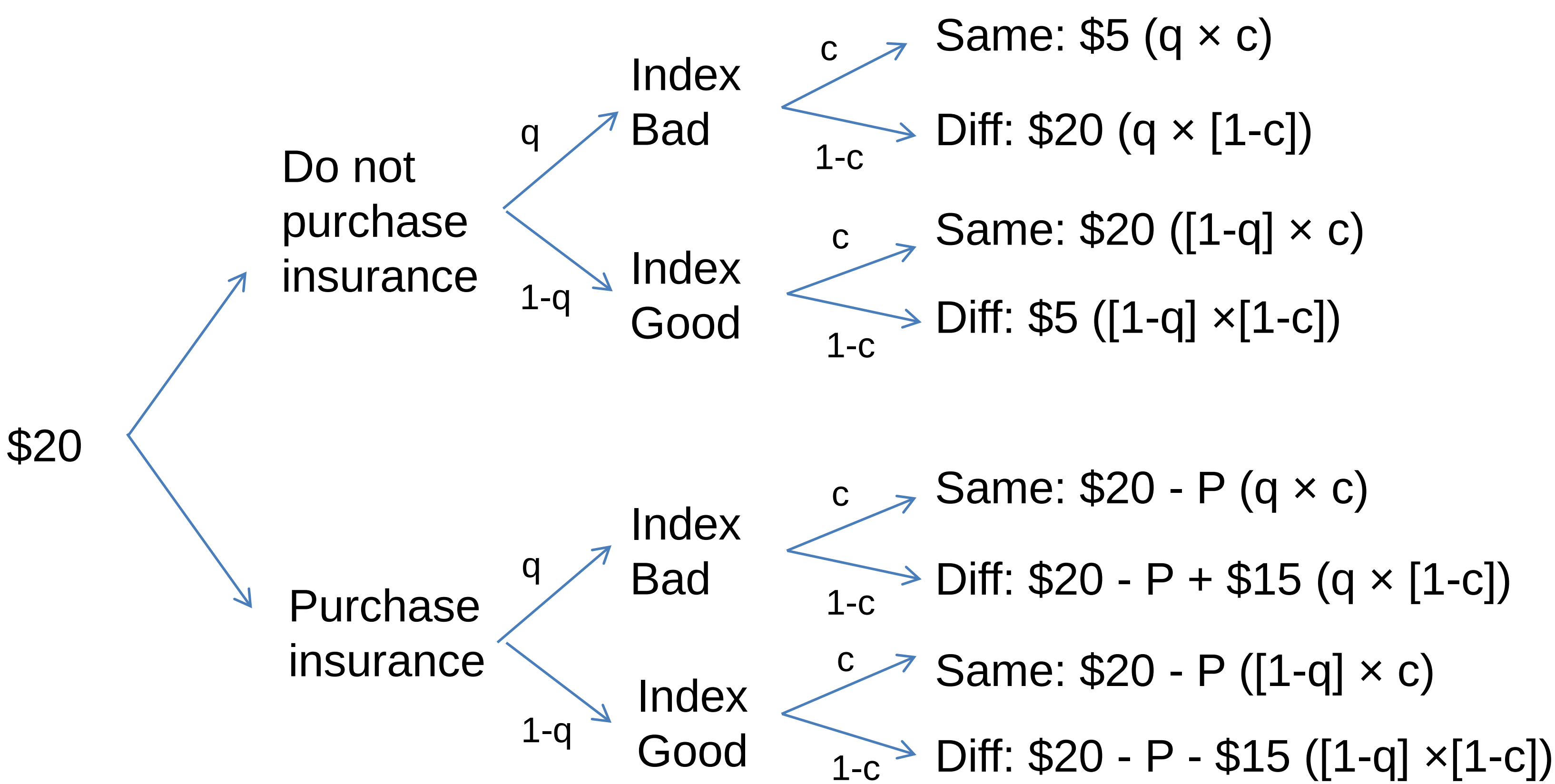
Do not purchase insurance

Purchase insurance

Index Insurance



Index Insurance



Index Insurance

> Insurance task

- Correlation defined as probability an individual's personal outcome matches that of a separate index
- Two different treatments
  - II treatment – Index loss probability presented separately from correlation probability in insurance choice
  - Actuarially-equivalent (AE) treatment – Index loss probability and correlation combined to reflect probability of personal outcomes
- Compare insurance take-up and expected welfare gains evaluated for both treatments

How do we evaluate welfare?

- CRRA: $U(x) = x^{(1-r)}/(1-r)$
  - Here r = 0 is RN, r > 0 is RA, r < 0 is RL
- EUT: $EU_i = \sum_{j=1,J} [\ p(x_j) \times U(x_j)\ ]$
- RDU: $RDU_i = \sum_{j=1,J} [\ w(p(M_j)) \times U(M_j)\ ]$
  - $w_j = \omega(p_j + \ldots + p_J) - \omega\ (p_{j+1} + \ldots + p_J)$
  - ω_j is the probability weighting function, w_j is the decision weight
  - Alternative probability weighting functions
    - power: $\omega(p) = p^\gamma$
    - inverse-S: $\omega(p) = p^\gamma / (\ p^\gamma + (1-p)^{\gamma}\ )^{1/\gamma}$
    - Prelec: $\omega(p) = \exp\{-\eta(-\ln p)^\varphi\}$

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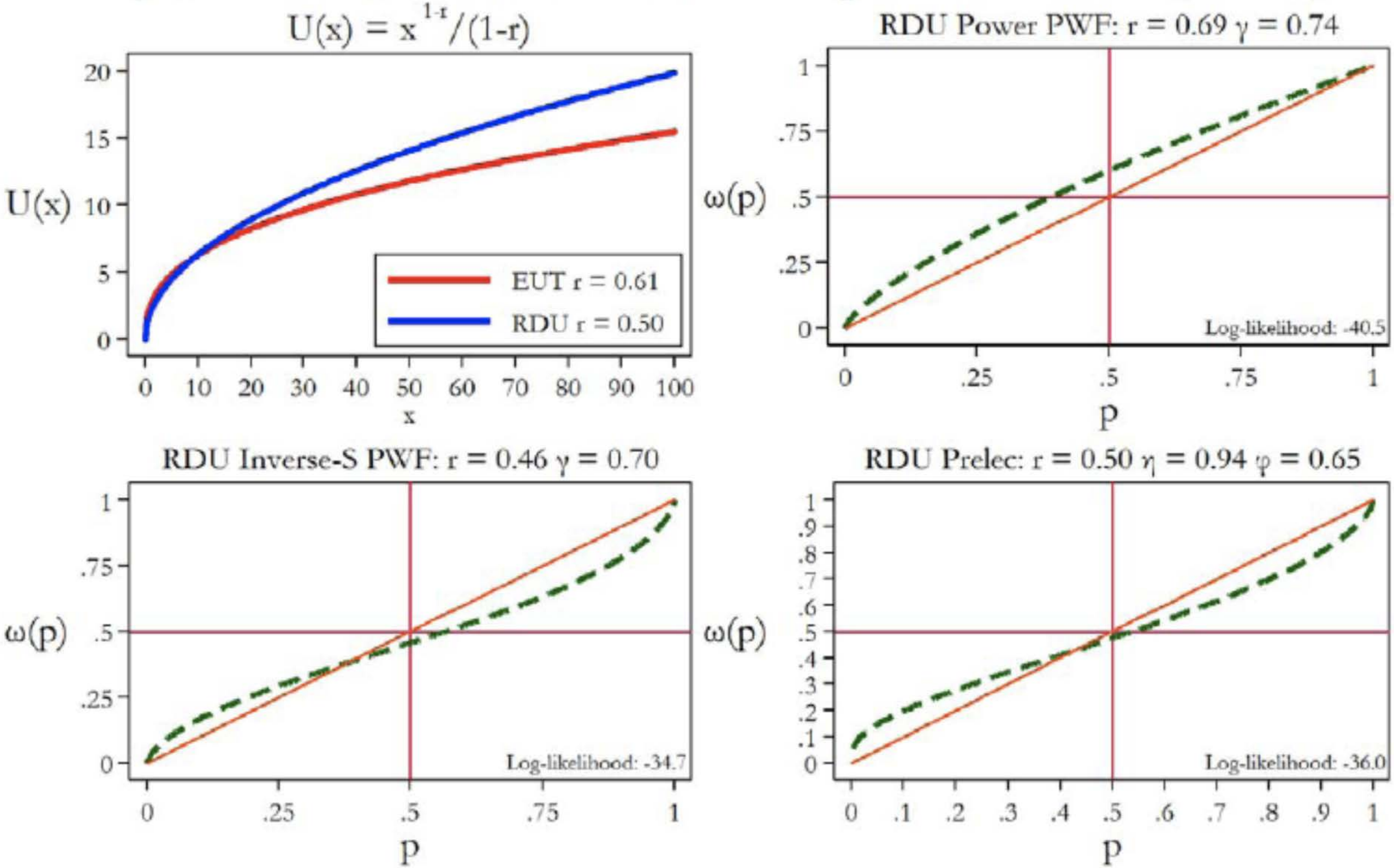
Figure 9: Estimated Risk Parameters for Subject #2

Subject #2 is classifed RDU with EUT *p*-value = 0.000 (< 0.05)



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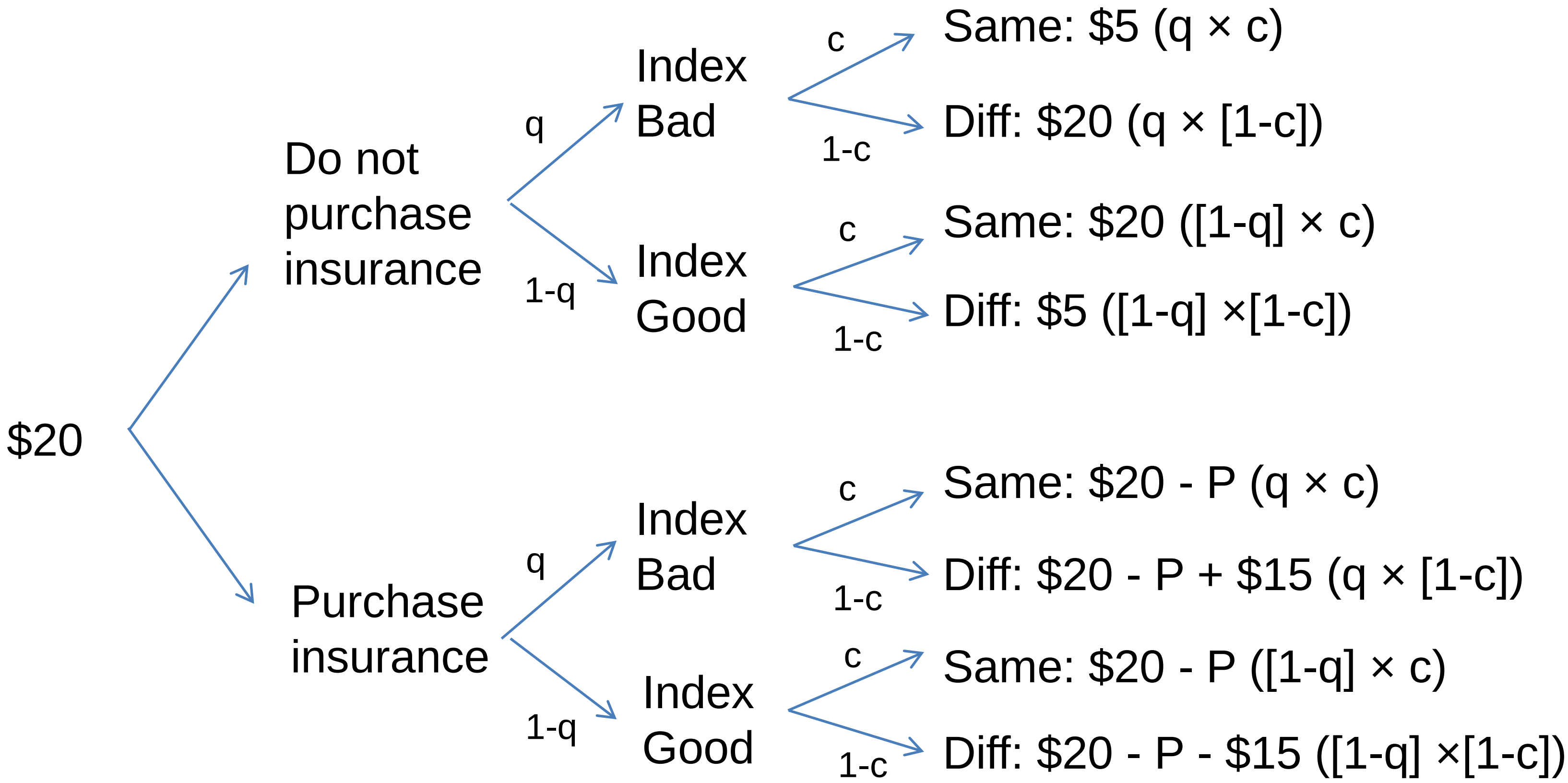
Index Insurance



> Consumer Surplus (CS) from insurance

- CE(with insurance) – CE(without insurance)

Experiment

> Insurance task (32 choices)

- Loss probability = 10% or 20%
- Premium = $0.50, $1.20, $1.80, $3.50
- Correlation = 100%, 80%, 60%, 40%

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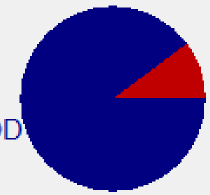
Your initial stakes are **$20.00**.

You may **lose $15** or **not lose any money**, depending on the outcome of your **PERSONAL** event.

You have the option to purchase insurance, which will only compensate for the $15 loss if the outcome of the **INDEX** is **BAD**.

This insurance will cost you **$1.80**.

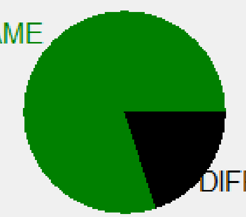
INDEX Probability



10% BAD

90% GOOD

PERSONAL Probability



80% SAME

20% DIFFERS

Possible Outcomes **WITHOUT Insurance**

Index is **BAD** and Personal **MATCHES**: **$5**

Index is **BAD** and Personal **DIFFERS**: **$20**

Index is **GOOD** and Personal **MATCHES**: **$20**

Index is **GOOD** and Personal **DIFFERS**: **$5**

DO NOT BUY INSURANCE

Possible Outcomes **WITH Insurance**

Index is **BAD** and Personal **MATCHES**: **$18.20**

Index is **BAD** and Personal **DIFFERS**: **$33.20**

Index is **GOOD** and Personal **MATCHES**: **$18.20**

Index is **GOOD** and Personal **DIFFERS**: **$3.20**

BUY INSURANCE

Experiment

- Insurance task (32 choices)
  - Loss probability = 10% or 20%
  - Premium = $0.50, $1.20, $1.80, $3.50
  - Correlation = 100%, 80%, 60%, 40%
- Insurance contracts
  - Index Insurance contract
  - Actuarially Equivalent simple contract
  - Index Insurance contract with a Contextual Clue

Your initial stakes are **$20.00**.

You may **lose $15** or **not lose any money**, depending on the outcome of your **PERSONAL** event.

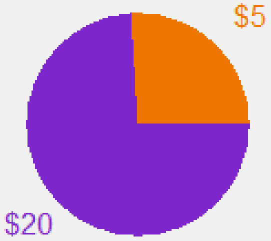
INDEX: 10% BAD, 90% GOOD

PERSONAL: 80% SAME, 20% DIFFERS

You have the option to purchase insurance, which will only compensate for the $15 loss if the outcome of the **INDEX** is BAD.

This insurance will cost you **$1.80**.

Without Insurance



26% chance you keep **$5.00**.

74% chance you keep **$20.00**.

DO NOT BUY INSURANCE

With Insurance

18% chance you keep **$3.20**.

80% chance you keep **$18.20**.

2% chance you keep **$33.20**.

BUY INSURANCE

Contextual Clue treatment (33 subjects)

Information on Real-World Counterpart

This task is based on a real-world insurance product known as index insurance, widely used for farmers who grow crops in poor countries.

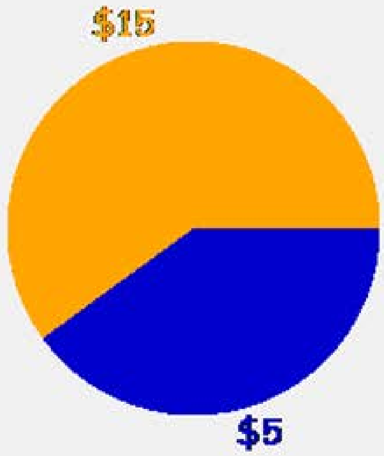
Index insurance is insurance that is linked to an index such as rainfall, temperature, humidity or crop yields, rather than an actual loss. An example of index insurance is the use of an index of rainfall totals to insure against drought-related crop loss. Payouts occur when rainfall totals over some time period fall below some pre-agreed threshold that can be expected to result in crop loss in a geographic area.

One advantage of using the index is that, unlike traditional crop insurance, the insurance company does not need to visit farmers' fields to assess losses and determine payouts. That is expensive to do, and means that traditional premiums would have to be too high for most farmers to afford. Instead, index insurance uses data from rain gauges near the farmer's field. If these data show the rainfall amount is below the threshold, the insurance pays out; if the data show the rainfall amount exceeds the threshold, the insurance does not pay out. All the insurance company has to do, to figure out if it should pay out, is check the rain gauge. This reduces the cost of providing insurance to these farmers.

Experiment

- Insurance task (32 choices)
  - Loss probability = 10% or 20%
  - Premium = $0.50, $1.20, $1.80, $3.50
  - Correlation = 100%, 80%, 60%, 40%
- Insurance contracts
  - Index Insurance contract
  - Actuarially Equivalent simple contract
  - Index Insurance contract with a Contextual Clue
- Risk preferences (76 choices)
  - Test for IA of EUT (30 choices)
  - Test for ROCL (30 choices)
  - “Naked AE” (16 choices)

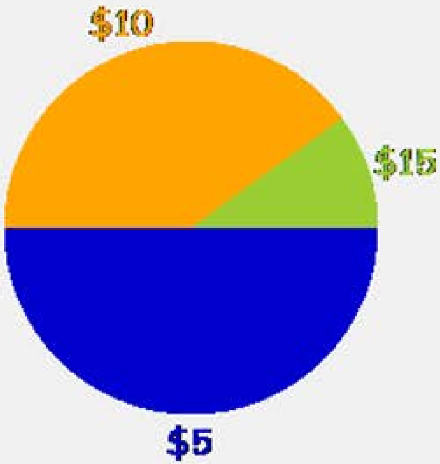
Left



Chance of winning $5 is 40%
Chance of winning $15 is 60%

Select Left

Right

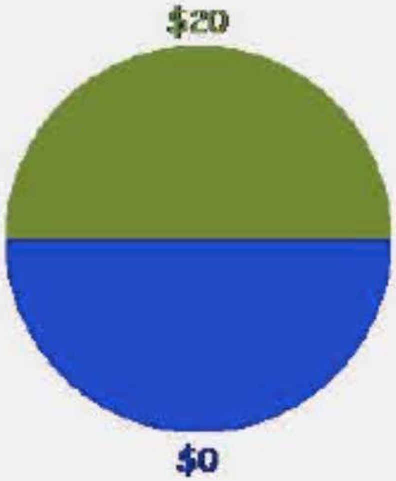


Chance of winning $5 is 50%
Chance of winning $10 is 40%
Chance of winning $15 is 10%

Select Right

One prospect has a Double Or Nothing option

Double or Nothing for any outcome



Chance of winning $0 is 50%

Chance of winning $20 is 50%

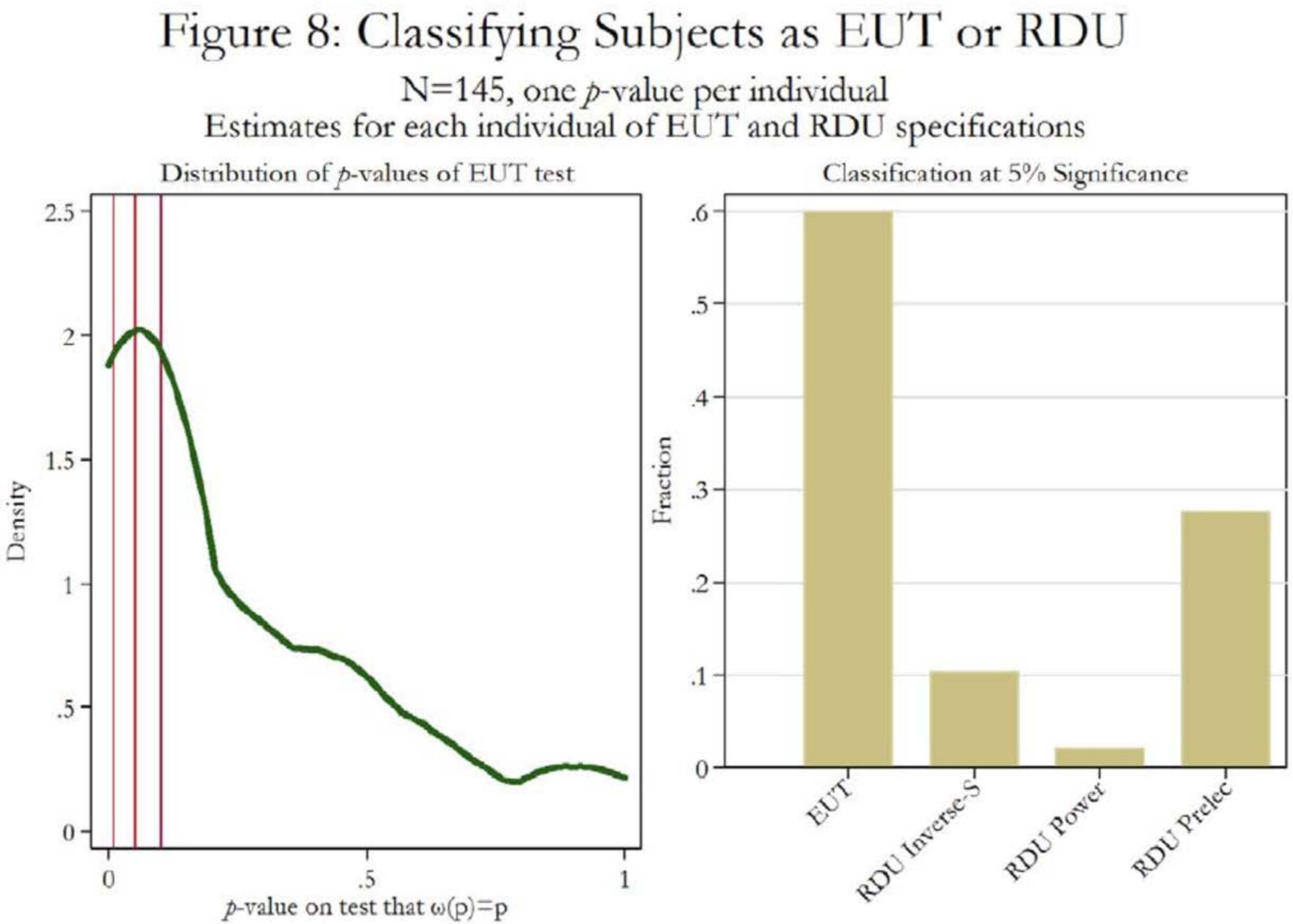
Chance of winning $10 is 50%

Chance of winning $20 is 50%

Select Left

Select Right

Risk preferences assuming ROCL

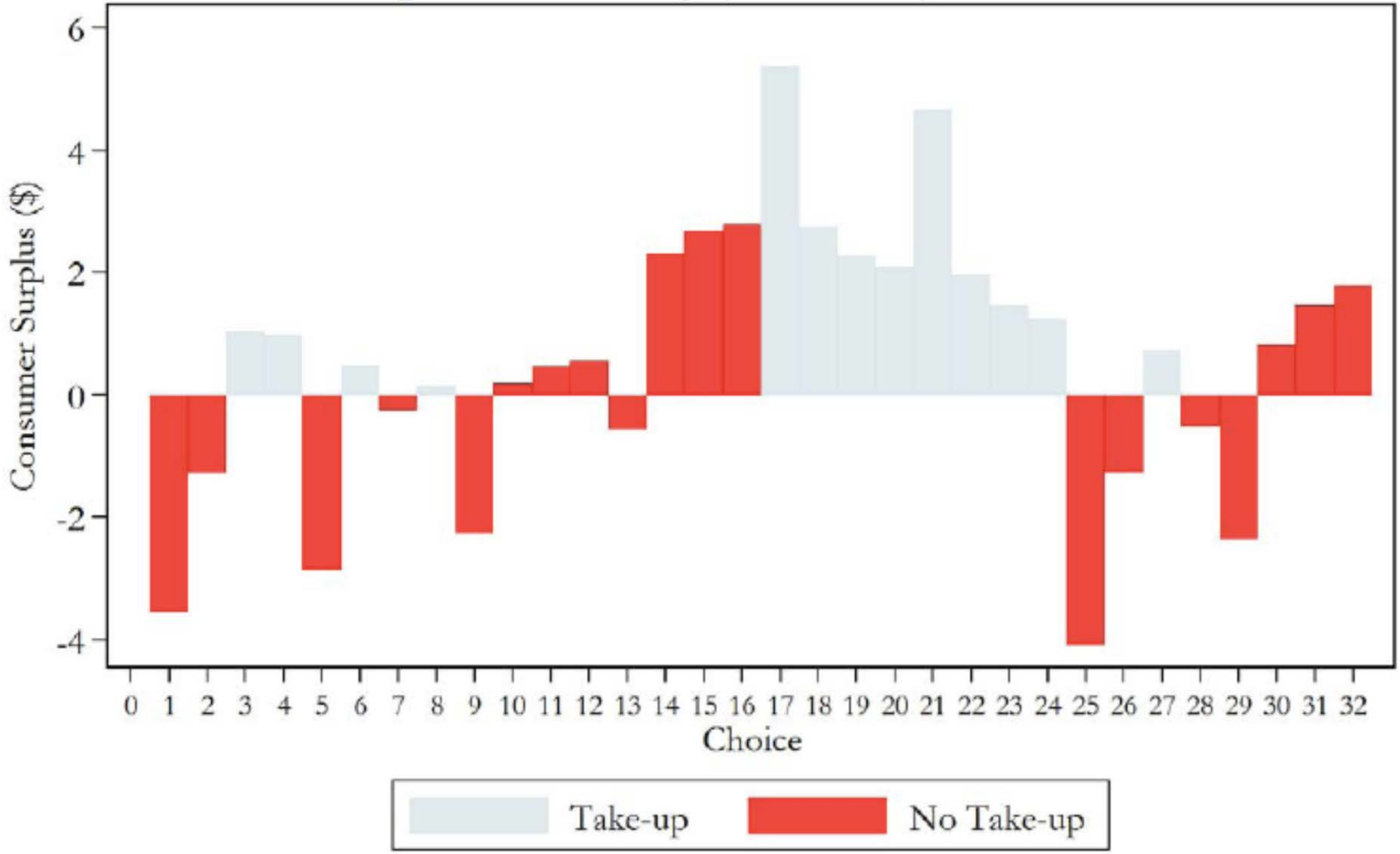


Results

- Comparing welfare gain against actual take-up
  - Significant difference between predicted and observed take-up

Figure 11: Consumer Surplus of Choices of Subject #2

Rank Dependent Utility (Inverse-S) Risk Preferences



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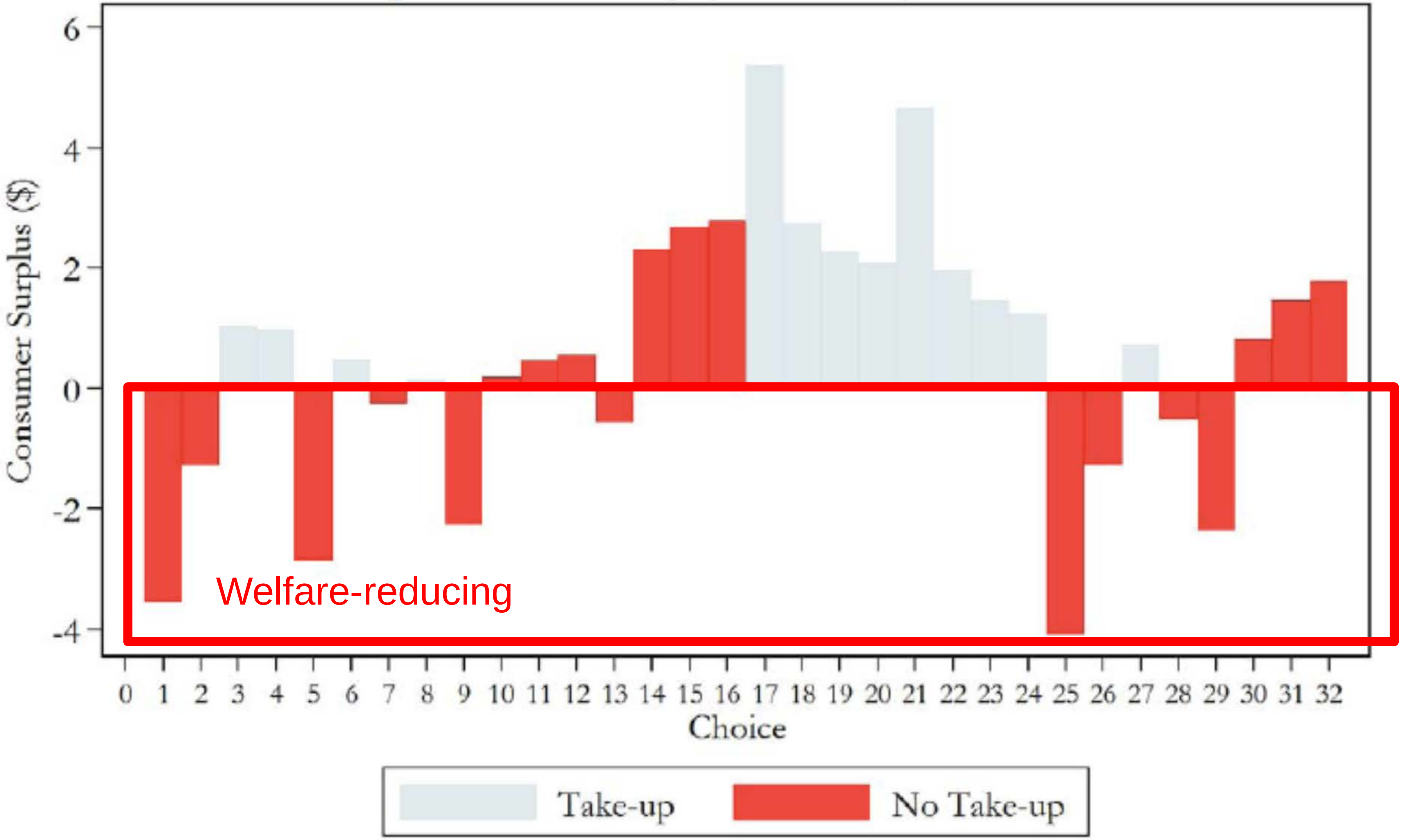

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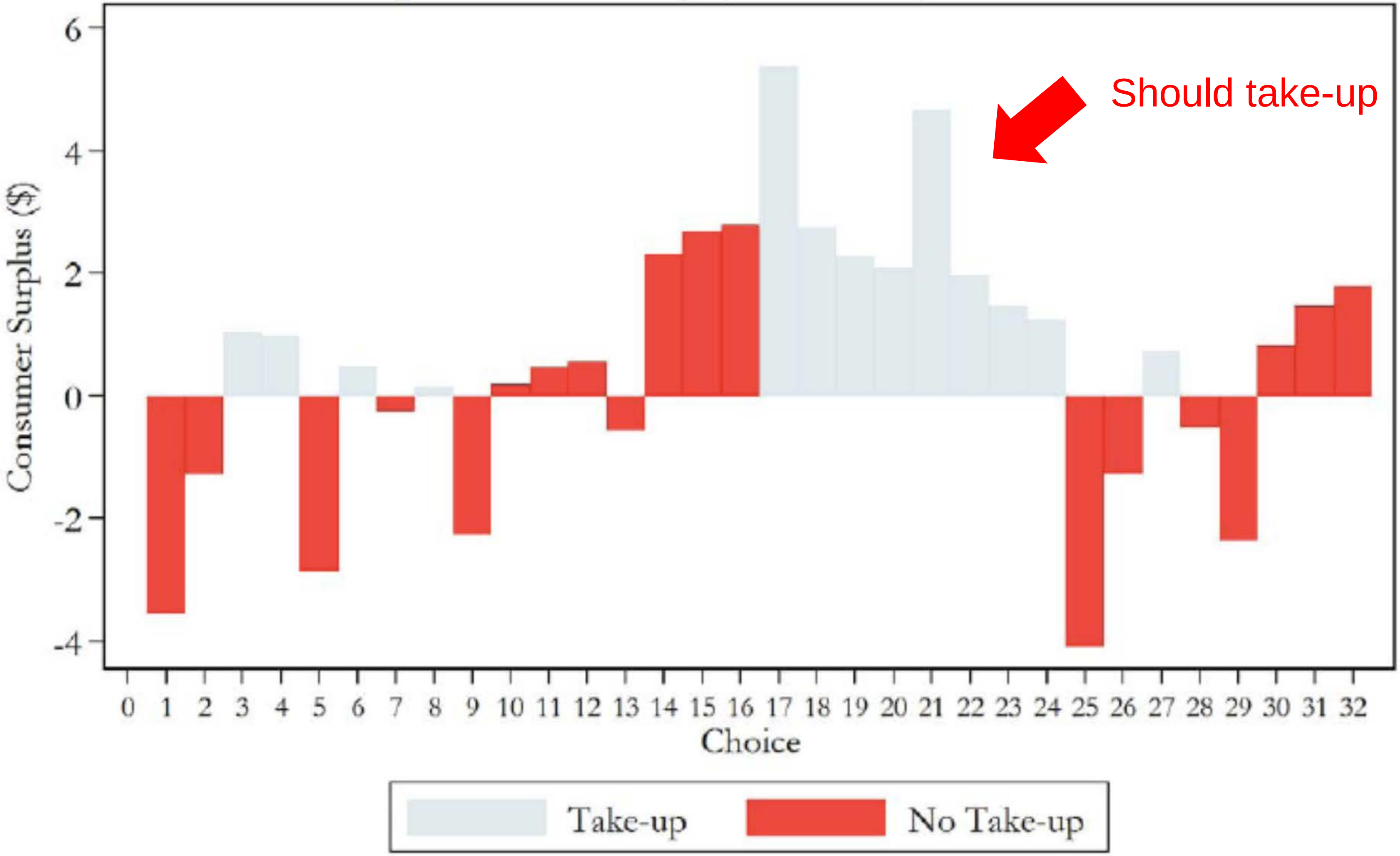

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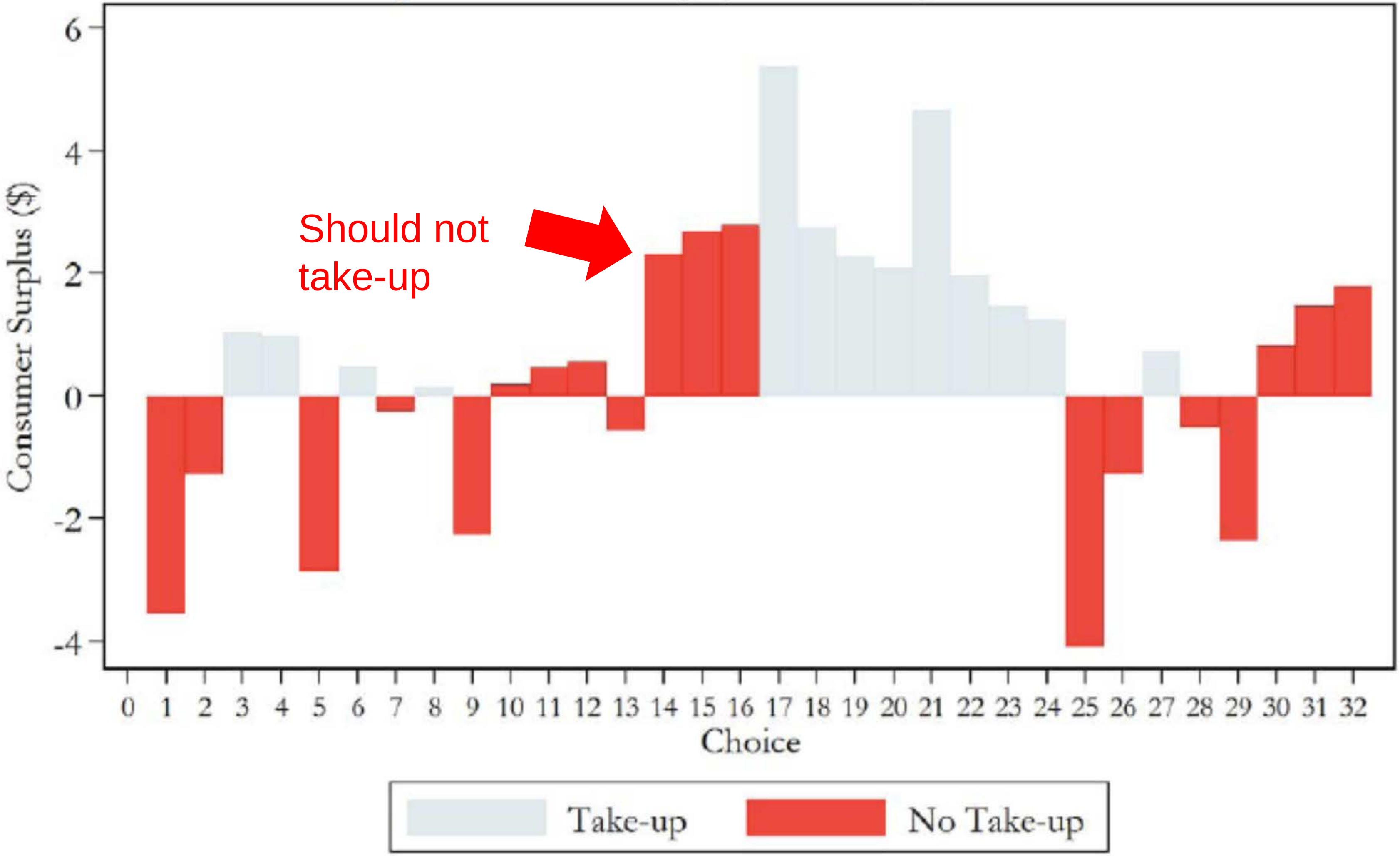
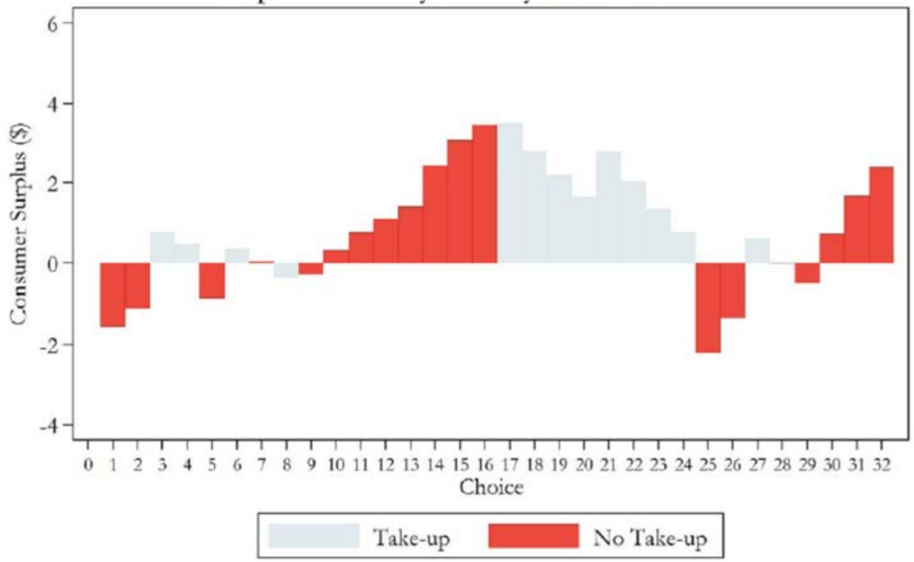


Figure 10: Consumer Surplus of Choices of Subject #2
Expected Utility Theory Risk Preferences



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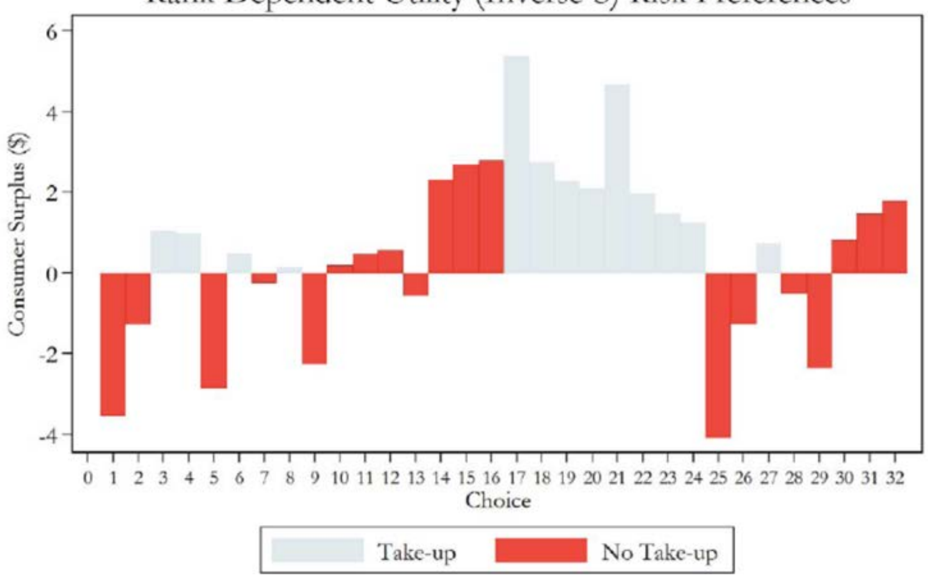
Rank Dependent Utility (Inverse-S) Risk Preferences



Results

- Comparing welfare gain against actual take-up
  - Significant difference between predicted and observed take-up
- Impact of compound risk in basis risk
  - II has lower take-up and welfare than AE
  - Efficiency – actual CS as a % of total possible CS

Figure E1: Proportion of Actual Take-Up to Predicted Choices (II)

Fisher Exact Test 2-sided p-value < 0.001

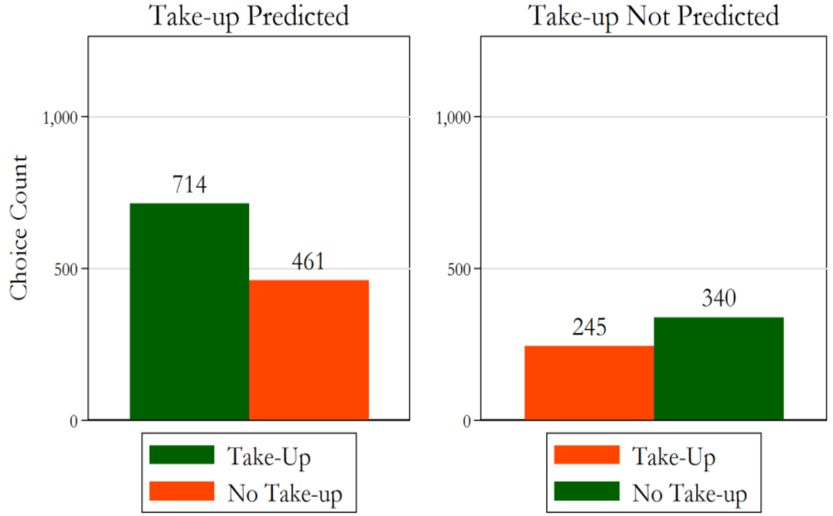


Figure E2: Proportion of Actual Take-Up to Predicted Choices (AE)

Fisher Exact Test 2-sided p-value < 0.001

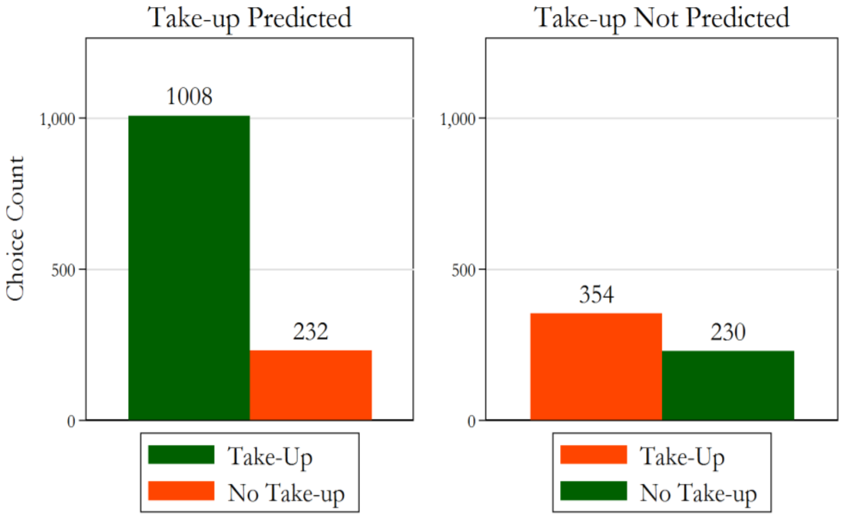
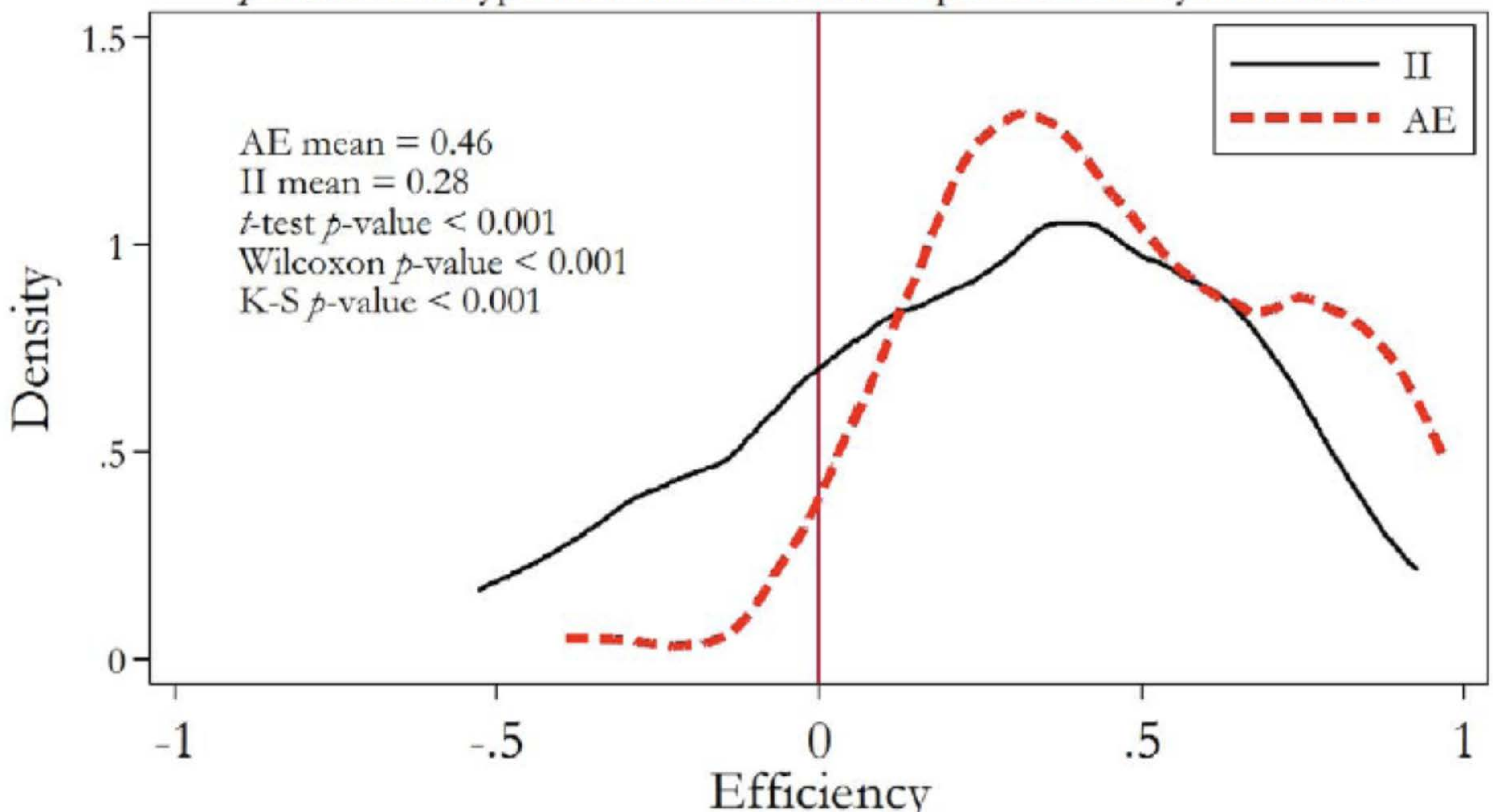


Figure 14: Comparison of Efficiency Distribution for II and AE Treatments

II treatment (N=55) against AE treatment (N=57)
p-values test hypothesis that treatment impacts efficiency distribution



Results

- Comparing welfare gain against actual take-up
  - Significant difference between predicted and observed take-up
- Impact of compound risk in basis risk
  - II has lower take-up and welfare than AE
  - Efficiency – actual CS as a % of total possible CS
- Proponents of II advocate…
  - Lowering premia and/or increasing correlation
  - No statistically significant effect on welfare for compound risk
- But improving ROCL consistency does help
  - Each subject has a ROCL consistency count between 0 and 15
  - Δ ROCL consistency count by 1

    $\rightarrow \Delta$ 5% impact on efficiency

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