
Detecting and modelling non-compensatory behaviour in transportation

With Recommendations for “not Perishing” in
Research

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Outline

1. Recommendations for “not perishing” in research
2. Detecting and modelling non-compensatory behaviour in transportation



Recommendations for “not Perishing” in Research:

Mainly Adapted from:

de Neufville, R. (1988) “Thesis Definition and Preparation Guidelines” TPP Program at MIT.

The Research “Ghost”



Source: Phipipao's Gentle Ghost

The Research “Ghost”

- Research is inherently difficult to formulate
 - A trip to the unknown...and beyond
 - Serious research => serious compromise of time, \$\$ and life!. Will it worth it?
 - Results cannot be anticipated
 - Methods and data are difficult to choose because everything is related
 - Agony could be “bounded” if you know what you are looking for, and plan properly
 - Lack of motivation is a critical problem
-

What Is Research?

- **Proposition** that somebody offers to maintain or **sustain an argument**
 - **Proposition:** Idea, Hypothesis, recommendation
 - **Argument:** Rationality that sustains the proposition
 - **Sustained:** Should be sustained in the logic, suitable and enough evidence
 - **Good research:** raises a question, suggest an answer, tries to validate it
-

What Is Research? (2)

- Essential Elements
 - Which is the **question**?
 - Which **method** will be used to answer this question?
 - Which **evidence** could be applied?
 - Which **logic** integrates it all?

A Question!

- Research hinges on a question
- Research is NOT defined by a topic
 - Getting into a topic is only the first stage toward making a good question
- Question should have more than one possible answer. Our research may surprise us!

A Question! (2)

- Should be interesting. We are going to invest lots on it. Make it worth!
- We should ask ourselves if the answer may have some potential to make a difference
- The question should be relevant for some audience and **FOR YOU!**

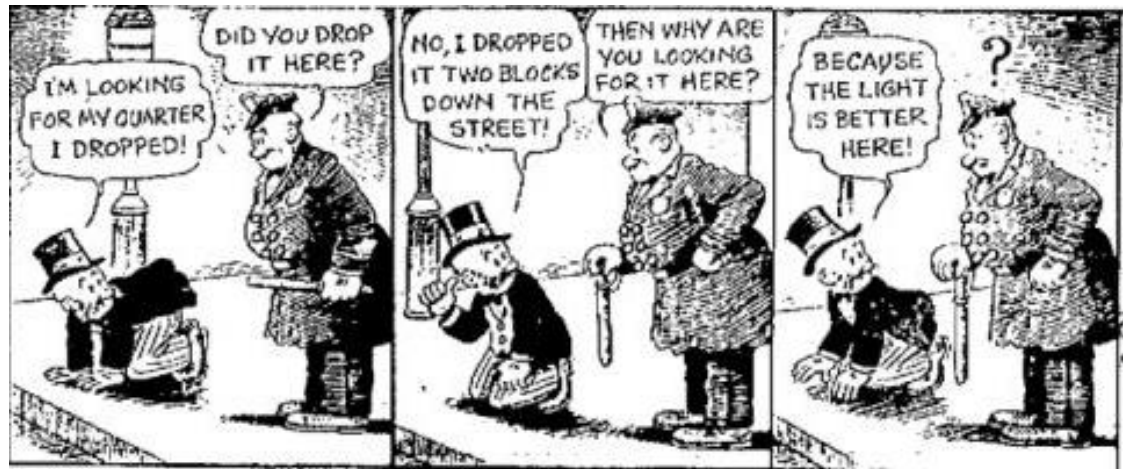
A Suitable Method

- Obvious: The method should allow us answering our questions
- Mistake: Many choose the method because they know it, they have the software or even by chance

“Not because I have a hammer in my hand, what it is in front of me is a nail, it could be a screw”

– Avoid the “street light effect”

Observational bias caused by being searching only where it is easier



Source: 1942 June 3, Florence Morning News, Mutt and Jeff Comic Strip, Page 7, Florence, South Carolina. (NewspaperArchive)
Obtained online at <http://quoteinvestigator.com>

A Suitable Method (2)

- If the question is unmanageable, it may be better to leave it aside
 - Better to find out soon!
 - Discarnate comments are the best help
- It helps to think on a specific method
 - e.g.:LP instead of optimization
- The method should be feasible:
 - Lab, Know-how, resources, etc.
- Wrong choice=> lot of useless work

Evidence

- Relevant **FACTS** to sustain argument
- **WARNING:** Data availability is always a major problem
 - Be aware of uncertainties
 - Follow a fail-proof strategy: Secure minimum necessary data before proceeding. Have various “bullets”
 - Having problems with data is **NOT** an excuse for bad research

Logic

- Integration of the method and the evidence that supports the argument
 - How do we know that we have answered our question satisfactorily?
 - Are our potential results enough to sustain the point we want to make?
 - NO?: Change question or the method
 - Logic has to adapt to the audience: psychology v/s economy
-

Final recommendations

- Consider question, method evidence and logic **simultaneously**
 - Iterative process
 - Always prototype!
 - Use critical experiments
 - Help deciding among methods
 - Good paper independent of result
 - Requires good understanding of the topic (deep literature review is a must)
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Case Study:

Detecting and modelling non-compensatory behaviour in transportation

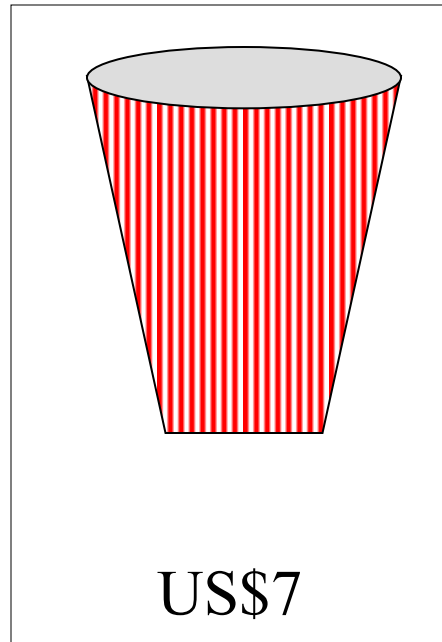
Guevara and Fukushima (2015)

Outline

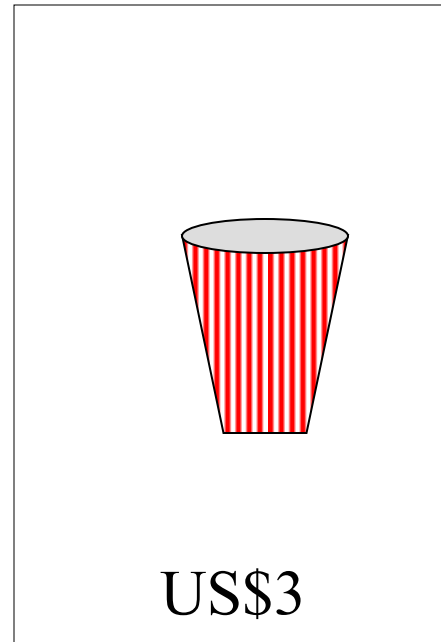
1. Motivation
2. The decoy effect
3. Modeling the decoy effect
4. Detection of the decoy effect
5. The decoy effect in transportation
6. Conclusion

1. Motivation

- The pop-corn paradox



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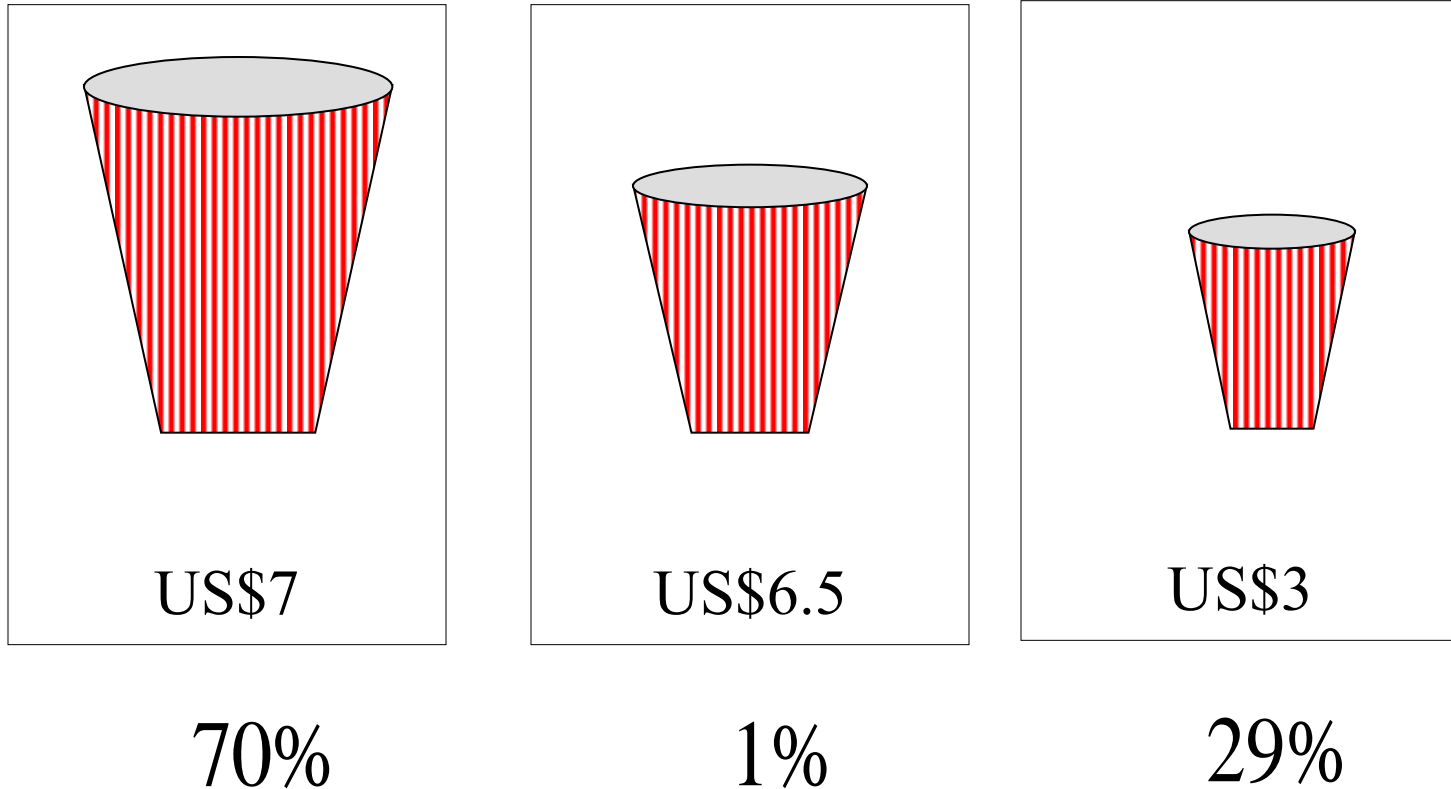


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1. Motivation (Cont.)

- The pop-corn paradox (cont.)



- Choice reversal due to a decoy

1. Motivation (Cont.)

- Midsize package acts as a decoy, inducing choice of the large package
- Decoy effect detected in various areas, but not so far in transportation
- Lack of probabilistic choice-models that can replicate the decoy effect

1. Motivation (Cont.)

- Goals

Fail-
proof
strategy

- I. Devise probabilistic choice-models that can replicate the decoy effect
- II. Use empirical power to devise an optimal test to detect the decoy effect
- III. Devise and apply a route-choice SP experiment to detect the decoy effect

Multiple bullets

Question, Method, Evidence, Logic?

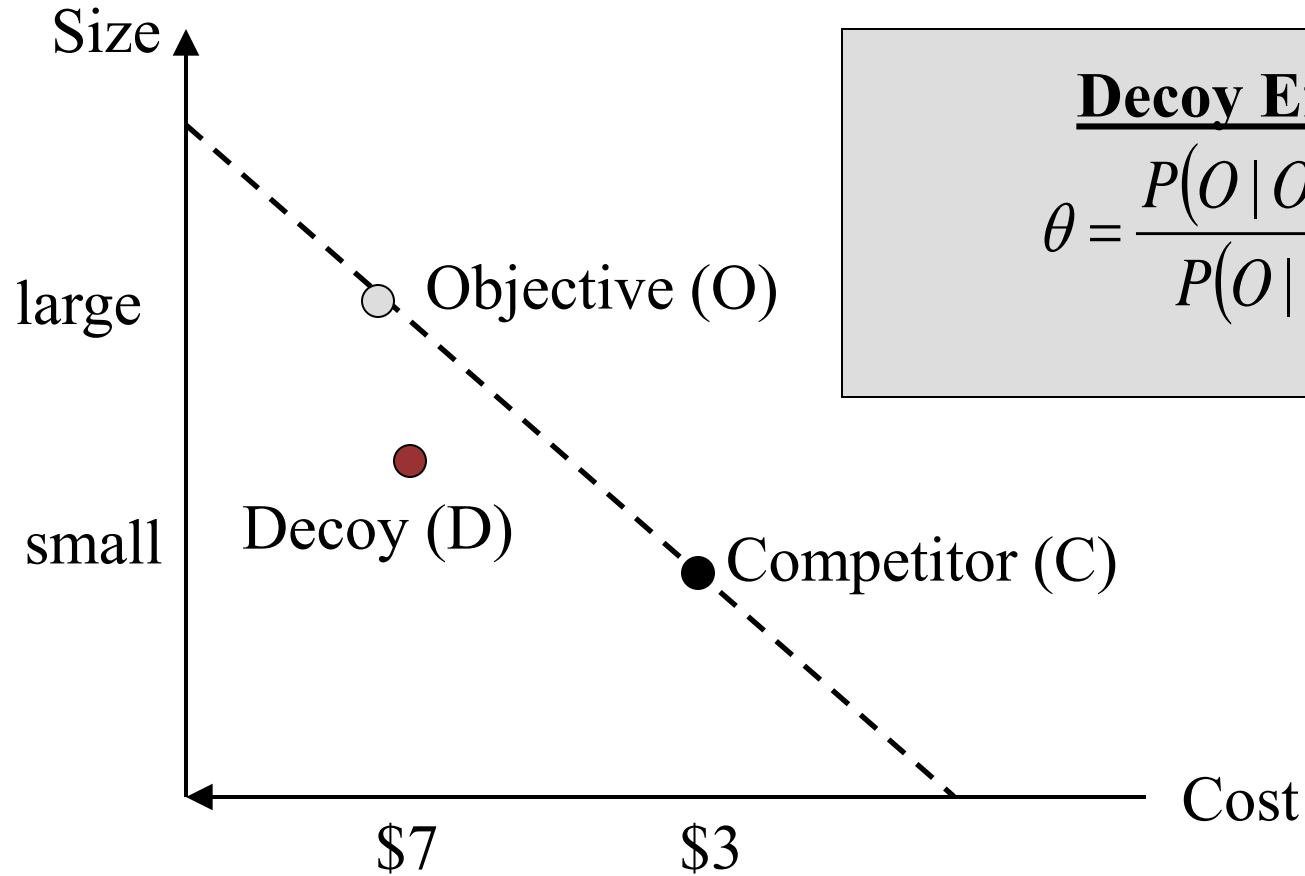
2. The Decoy Effect

Impact of introducing a new alternative?

- Proportionality (Luce, 1959)
 - New alt. takes from others in prop. to original shares:
Logit's IIA property
- Similarity (Tversky, 1972)
 - New alt. takes more from those similar: **Nested Logit**
- Regularity (Luce, 1977)
 - Probability of member of original set cannot increase
 - The decoy effect is a violation of regularity.
 - **Neither Logit nor Nested Logit can replicate the decoy**

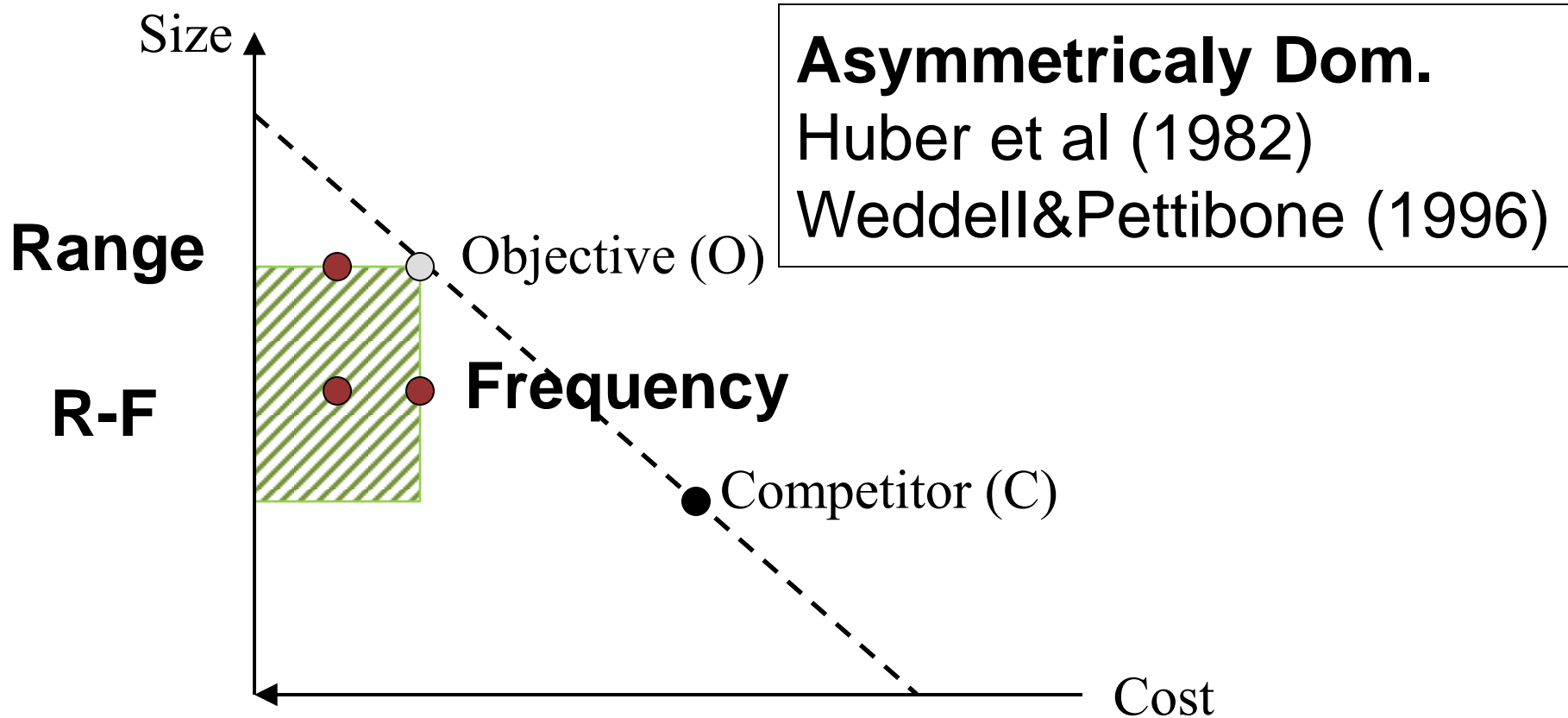
2. The Decoy Effect

- Definition -- trade-off line



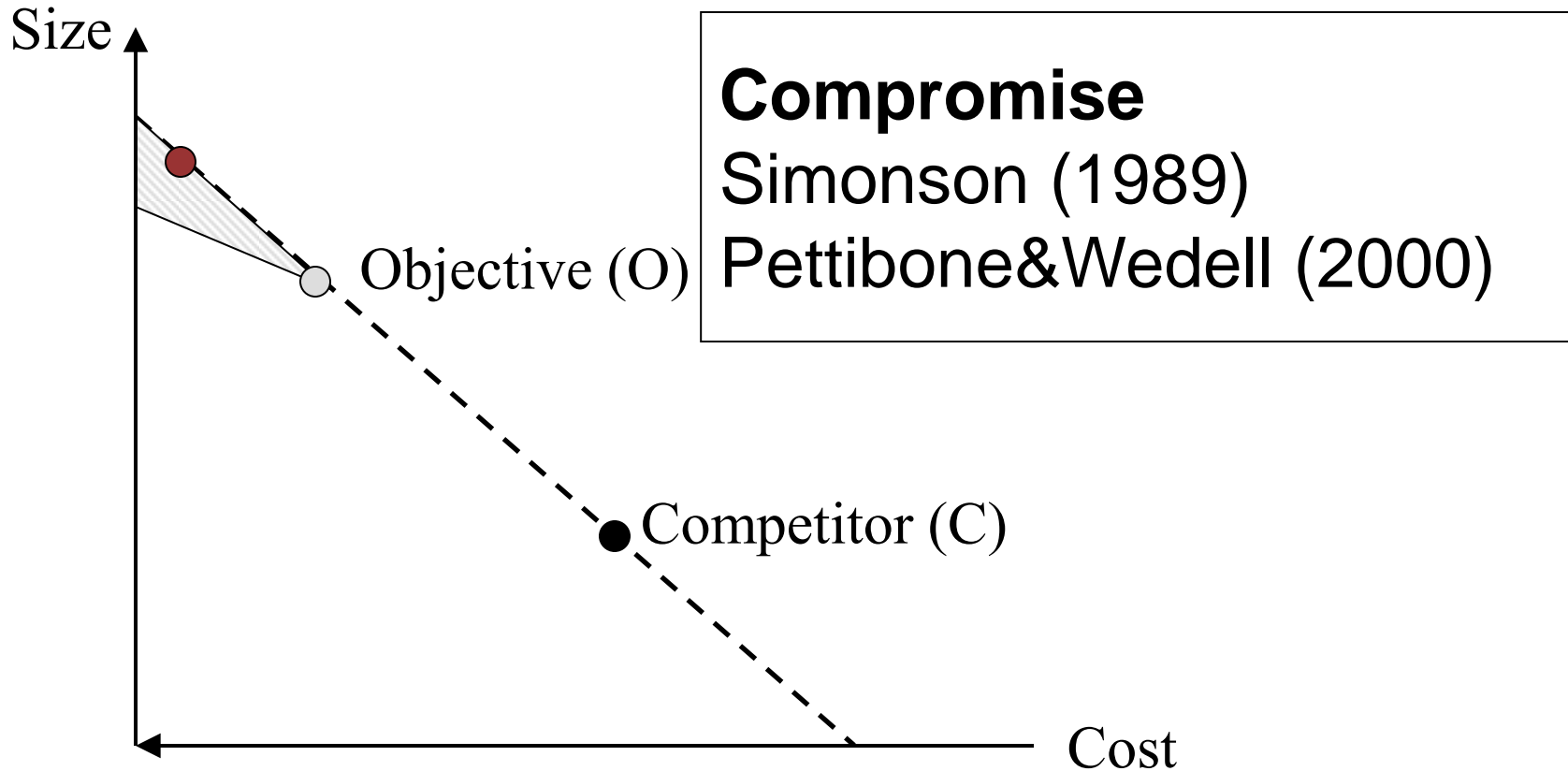
2. The Decoy Effect (cont.)

- Types of Decoys: Dominated



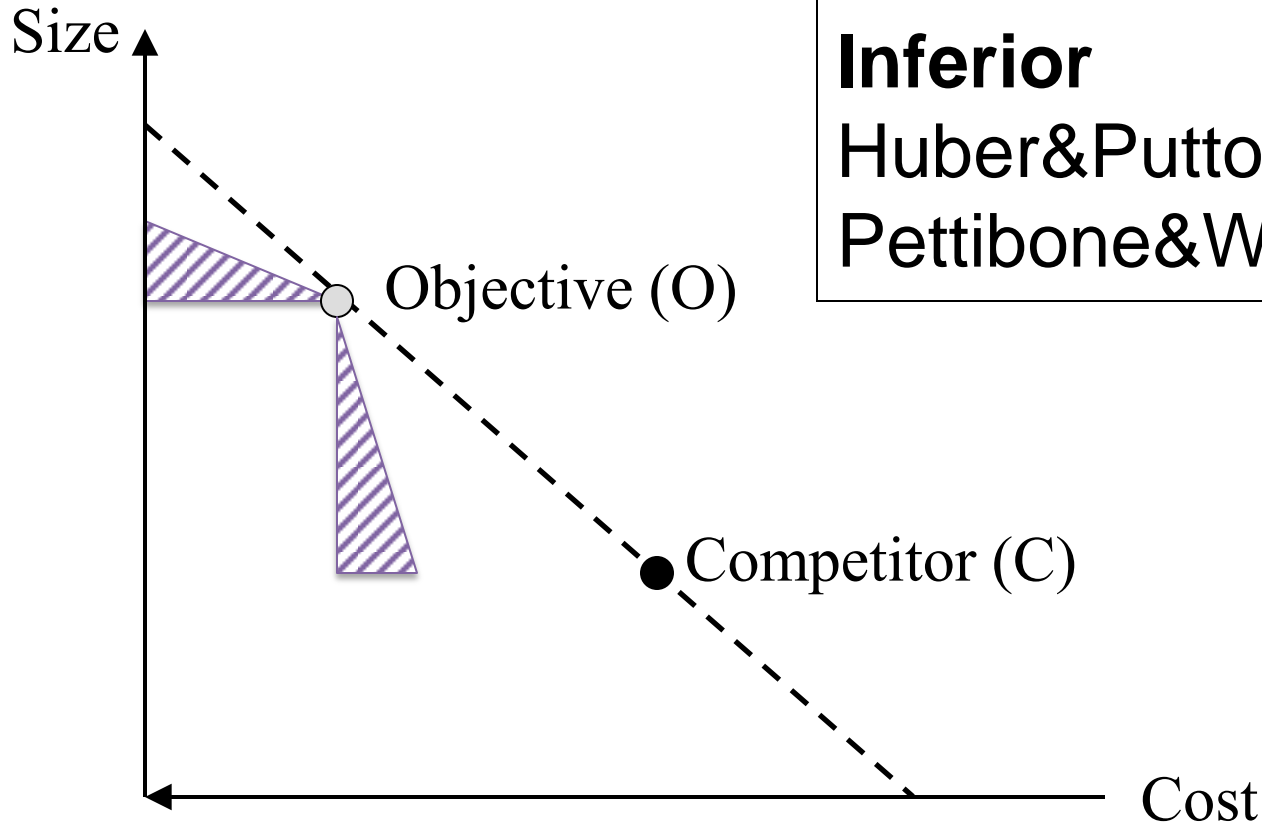
2. The Decoy Effect (cont.)

- Types of Decoys: Non Dominated



2. The Decoy Effect (cont.)

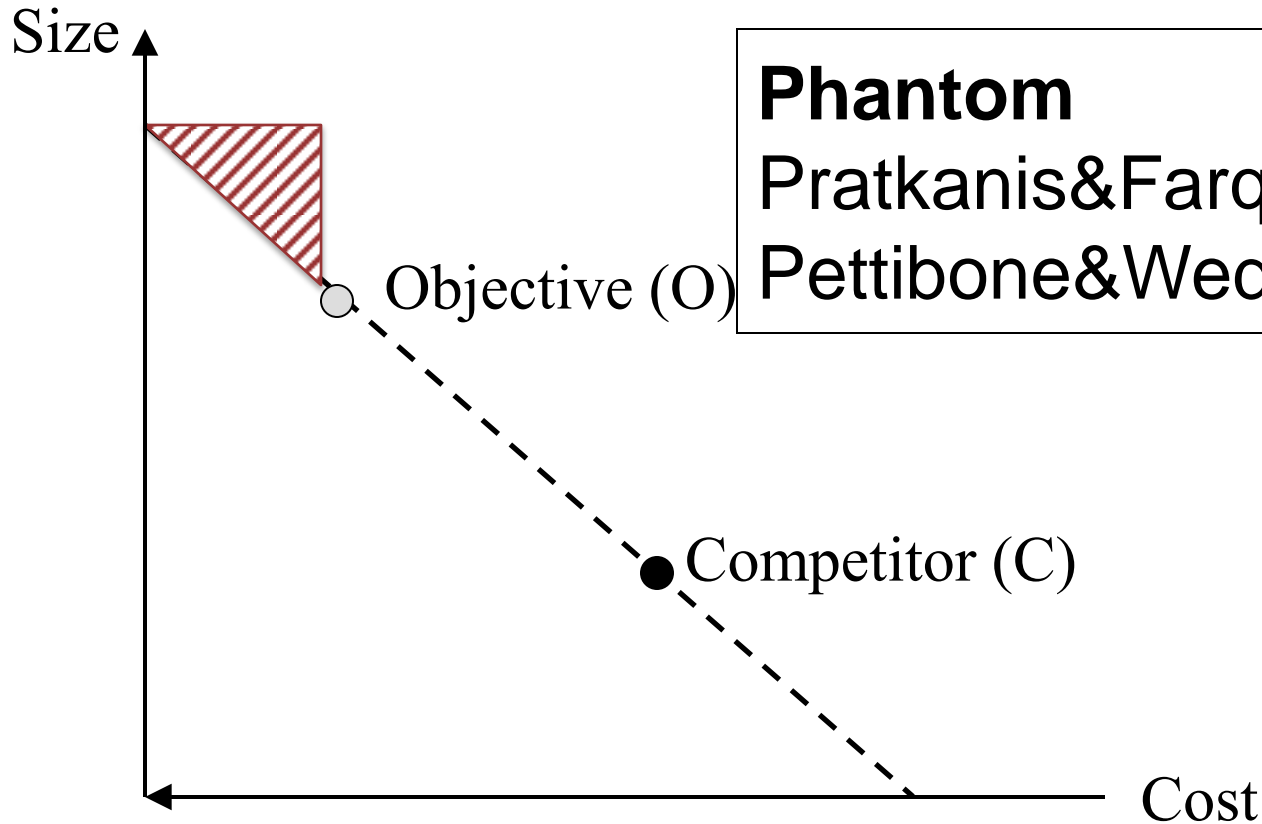
- Types of Decoys: Non Dominated (c.)



Inferior
Huber&Putto(1983)
Pettibone&Wedell(2000)

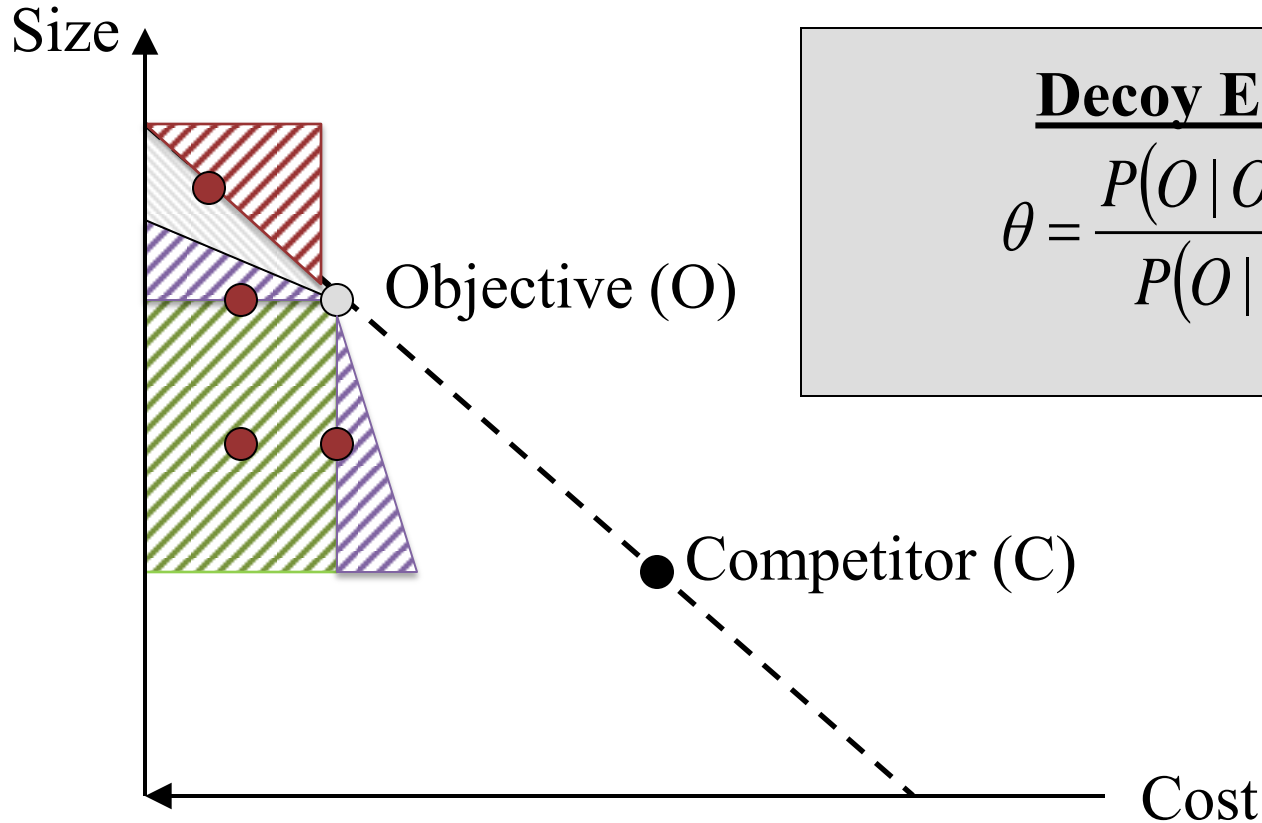
2. The Decoy Effect (cont.)

- Types of Decoys: Non Dominated (c.)



2. The Decoy Effect (cont.)

- Types of Decoys



3. Modeling the Decoy Effect

- Behavioral explanations for the decoy effect have to consider the choice context

- **Weight change** (Ariely & Wallsten, 1995; Huber et al 1982.)

$$V_{in} = \beta_1 x_{1in} + \beta_2 x_{2in} \quad \text{somehow } \beta\text{s change with context}$$

- **Value shift** (Wedell, 1991)

$$V_{in} = \beta_1 x_{1in} + \beta_2 x_{2in} \quad \text{somehow } x\text{s change with context}$$

- **Emergent Value** (Wedell & Pettibone, 1996)

$$V_{in} = \beta_1 x_{1in} + \beta_2 x_{2in} + J_{in} \quad \text{somehow } J_{in} \text{ changes with context}$$

- **Loss aversion** (Tversky & Kahneman, 1991; Wedell & Pettibone, 1996)

Choice-makers care more about losses than gains

3. Modeling the Decoy Effect

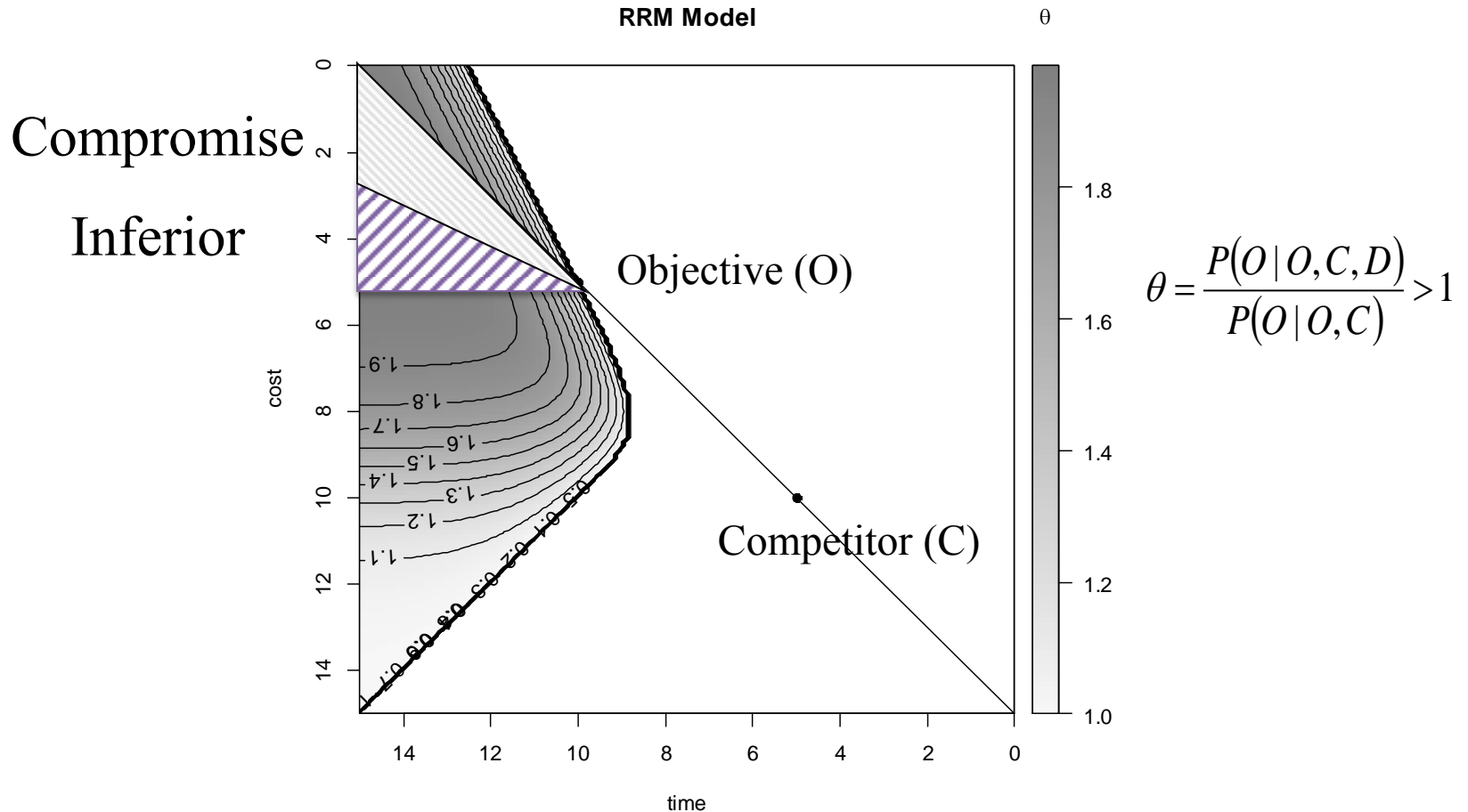
- Practical choice model?
 - We explored and extended various adaptations of conceptual choice models
 - RRM (Chorus, 2010) loss-aversion model showed results coherent reported decoys

Critical
Experiment

$$RR_{in} = R_{in} + \varepsilon_{in} = \sum_{\substack{j \neq i \\ j \in C_n}} \ln(1 + \exp[\beta(x_{jn} - x_{in})]) + \varepsilon_{in}$$
$$P_n(i) = \frac{e^{-\mu R_{in}}}{\sum_{j \in C_n} e^{-\mu R_{jn}}}$$

3. Modeling the Decoy Eff. (cont.)

- Can RRM model the decoy effect?



3. Modeling the Decoy Eff. (cont.)

- Neither Logit nor Nested Logit can account for the decoy effect
- RRM
 - Replicates all types of decoys that have been detected empirically
 - Larger decoy would be a mix of “inferior” and “compromise”

4. Detection of the Decoy Effect

- Experiments
 - Ask for choice between three alternatives: A, B and D (Decoy).
 - Decoy sometimes favors A and others B.
- Contingency table
 - Count choices, excluding those that chose D

Decoy on B

	Choose A	Choose B
Decoy on A Choose A	N_{AA}	N_{AB}
Choose B	N_{BA}	N_{BB}

4. Det. of the Decoy Effect (Cont.)

- Various tests to detect the decoy effect
 - McNemar(1947) test marginal homogeneity

$$\begin{array}{ll}
 H_0 : N_{BA} = N_{AB} & \frac{(N_{AB} - N_{BA})^2}{N_{BA} + N_{AB}} \approx \chi^2 \\
 H_1 : N_{BA} \neq N_{AB} &
 \end{array}
 \quad \text{One tailed version also possible}$$

- Proportions: assuming Bernoulli

$$\begin{array}{ll}
 H_0 : N_{BA} = N_{AB} & p := \frac{N_{AB}}{N_{AB} + N_{BA}} \\
 H_1 : N_{BA} \neq N_{AB} & \frac{p - 0.5}{\sqrt{\frac{p(1-p)}{N_{AB} + N_{BA}}}} \approx t_{N_{AB} + N_{BA}}
 \end{array}$$

- Logit

$$\begin{array}{ll}
 H_0 : \beta_D = 0 & U_{A,n} = \beta_A + \beta_1 \text{size}_{A,n} + \beta_2 \text{cost}_{A,n} + \beta_D 1_{\text{Decoy}_A} + \varepsilon_{An} \\
 H_1 : \beta_D \neq 0 & U_{B,n} = \beta_1 \text{size}_{B,n} + \beta_2 \text{cost}_{B,n} + \varepsilon_{An}
 \end{array}$$

4. Det. of the Decoy Effect (Cont.)

- Monte-Carlo simulations to study empirical coverage of different tests

Test Type	Range		Freq		Range-Freq		Compromise	
	75%	95%	75%	95%	75%	95%	75%	95%
McNemar	70	93	70	96	65	93	73	95
Proportions	70	93	70	96	65	93	71	90
Logit	68	97	78	98	72	97	52	81

- McNemar and Proportions tests show better empirical coverage

4. Det. of the Decoy Effect (Cont.)

- Power of tests using convex combination of Logit and RRM. λ defines effect size

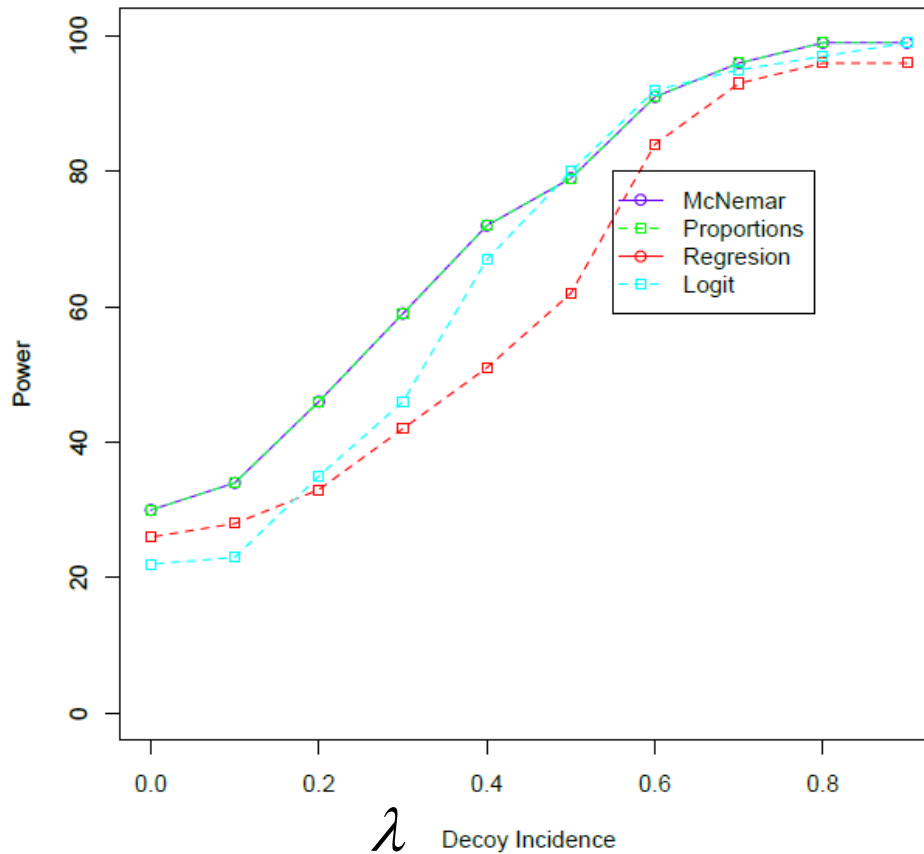
$$U_{in} = (1 - \lambda)V_{in} - \lambda R_{in} + \varepsilon_{in}$$

$\lambda = 0$ Logit. No decoy
 $\lambda = 1$ RRM. Full decoy

- Conclusion: McNemar and Proportions show larger power for all effect sizes

4. Det. of the Decoy Effect (Cont.)

- e.g. Power at 25% significance for R-F



5. The Decoy effect in Transportation

- Stated Preference Survey (SP) of route choice based on **time** and **cost**
- Pilot study showed that, to detect decoy, it was important to:
 - Inquire about unusual trip: shopping
 - Ask for a trip performed on a mode habitually used
 - Show alternatives that are close to trade-off line

5. The Decoy effect in Transportation (cont.)

- Stated Preference Survey (SP)
 1. Two subsequent choices to estimate individual's Value of Time (trade-off)
 2. Eight choices, 2 for each different decoy type: Frequency, Range, R-F, Compromise
 3. Characteristics of the respondent
- Data
 - 138 respondents , mainly undergrads
 - 4 observations per respondent
 - 1 observation:= decoy first on A (the cheapest) and then on B (the fastest)



Instrucciones:

Considere que debe viajar en auto a hacer una compra no habitual un día sábado a las 4 PM.

Elija la alternativa preferida considerando el costo y el tiempo de cada ruta. El costo incluye peajes, gasto en bencina, manutención, desgaste del vehículo, etc. El tiempo corresponde al tiempo total de viaje en el vehículo.

Ruta	Tiempo de Viaje	Costo	Elección
1	18 Min.	1000 Pesos	<input type="radio"/>
2	13 Min.	1400 Pesos	<input type="radio"/>
3	16 Min.	1100 Pesos	<input type="radio"/>

Continuar

5. The Decoy effect in Transportation (cont.)

- Contingency Table
 - 464 (from 552) valid observations

		Decoy on B	
		Choose A	Choose B
Decoy on A	Choose A	188	122
	Choose B	43	111

- Tests
 - McNemar $37.82 > \chi^2_{1,95\%} = 3.84$
 - Proportions $7.01 > t_{165-1,95\%} = 1.97$
 - Logit $7.62 > t_{928-1,95\%} = 1.96$
-

5. The Decoy effect in Transportation (cont.)

- Logit model with a dummy for decoy

$$\left. \begin{aligned} U_{A,n} &= \beta_A + \beta_1 time_{A,n} + \beta_2 cost_{A,n} + \beta_D 1_{Decoy_A} + \varepsilon_{An} \\ U_{B,n} &= \beta_B + \beta_1 time_{B,n} + \beta_2 cost_{B,n} + \varepsilon_{An} \end{aligned} \right\} \begin{aligned} &\hat{P}_n(i | Decoy) \\ &\hat{P}_n(i | no - Decoy) \end{aligned}$$

- Average Sample Effect to study the strength of the decoy

$$ASE = \frac{1}{N} \sum_{n=1}^N [\hat{P}_n(i | Decoy) - \hat{P}_n(i | no - Decoy)]$$

$$\hat{P}_n(i | no - Decoy) \approx 50\%$$

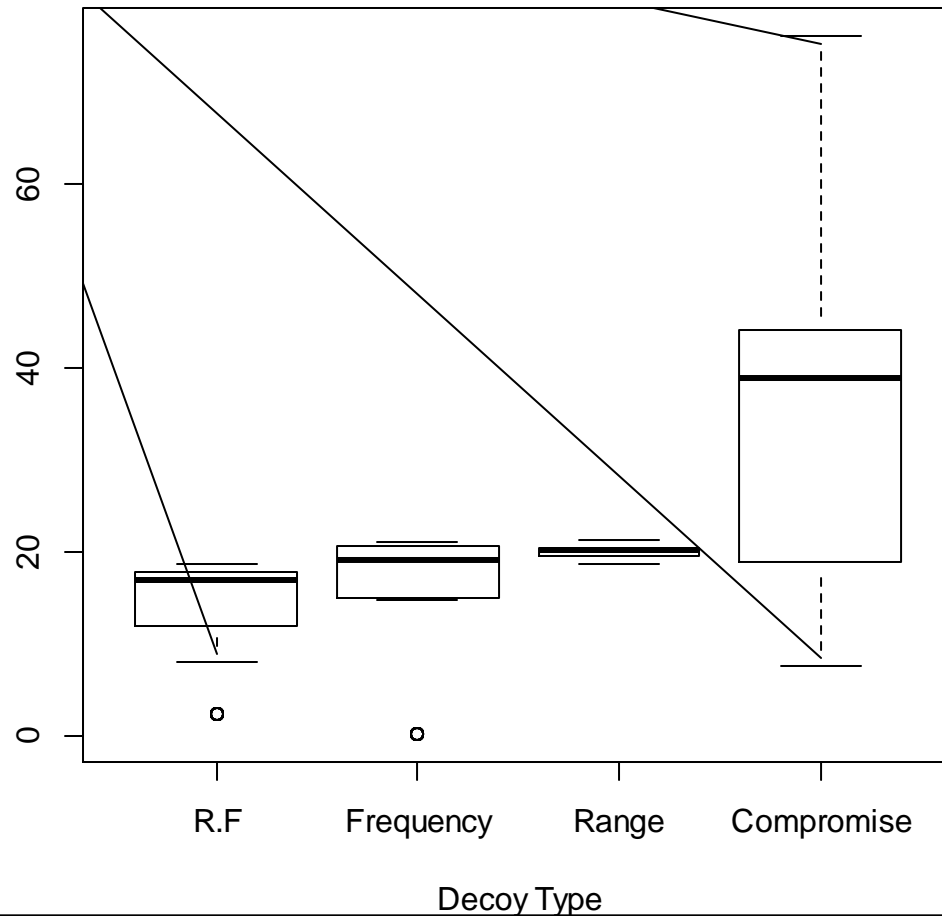
5. The Decoy effect in Transportation (cont.)

	ASE % (s.e.)	(s.e)
R-F	14.3	(0.265)
Frequency	17	(0.310)
Range	19.9	(0.0462)
Compromise	37.1	(1.31)

- ASE strength “coherent” with RRM
- Robustness: Range +, Compromise -

5. The Decoy effect in Transportation (cont.)

$$\hat{P}_n(i | Decoy) - \hat{P}_n(i | no-Decoy)$$



6. Conclusion

- Decoy effect often detected
 - But not so far in transportation
 - Lack of proper prob. choice model
- Modeling the decoy effect
 - The RRM replicates decoys outcomes
 - Under RRM, optimal decoys would be of the “compromise” type
- McNemar and Proportion tests show larger power and better emp. cov.

6. Conclusion (cont.)

- SP survey to detect the decoy effect in transportation
 - Decoy effect is present in SP route choice experiment. **Revealed Pref.?**
 - Strength of decoy type coherent with findings for RRM.
 - Robustness: Range +, Compromise -
 - Decoy hard to detect in commuting
 - Decoy hard to detect when alternatives were far from the “true” trade-off line

6. Conclusion (cont.)

- Further research
 - Improve the RRM model
 - Devise an Revealed Preference experiment to detect the decoy effect
 - Under what circumstances the Decoy occurs in Transportation?
 - Are, e.g., tolled highways a decoy for the use of private automobile?
 - Decoy to incentive the use of public transportation? e.g. only-seated buses?

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