Incorporating Strength of Preference Data into Bayesian Models of Choice

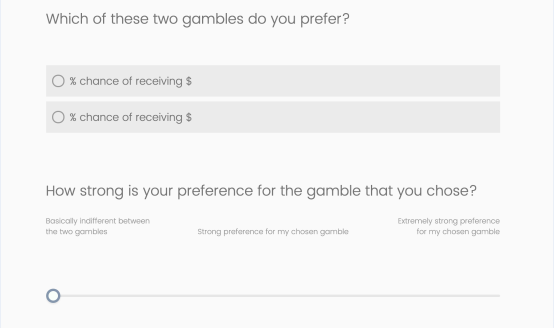
Jess Mixon and John McCoy, Wharton Marketing Department

Introduction:

- Gamble choice datasets allow behavioral economists to study individual decision processes involving risk
- In making a choice between 2 dollar/probability combinations people know both which option they prefer and how strongly they prefer it
- Eliciting strength of preference (SoP) data in conjunction with choices can likely improve baseline choice models

Study Data:

- 60 participants deciding between 225 pairs of gambles
- Payoffs ranging from \$3 to \$56.70 with probabilities ranging from 9% to 94%
- Each choice elicits strength of preference rating
- Final dataset also includes attractiveness and buy ratings of each of the 36 individual gambles for each participant



Baseline Model: Cumulative Prospect Theory (CPT) Kahneman and Tversky (1992)

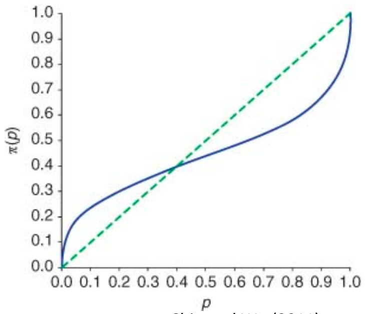
- individual level parameters α, γ, and φ
- Two-part process to arrive at an individual's probability of choosing one option over the other
- α and γ drive subjective valuation of both gambles separately
- φ translates difference between the subjective valuations into a probability of choosing the higher valued option

$$\pi(p) = \frac{p^{\gamma}}{\left(p^{\gamma} + (1-p)^{\gamma}\right)^{1/\gamma}}, \quad 0 < \gamma \le 1$$

$u(z) = z^{\alpha}$ (for z>0)

Parameters: For a pair of gambles with dollar amounts (z) and probability (p)

- α controls the degree to which people value monetary gains
- γ controls the degree to which the probability weighting function is S-shaped (ie. The degree to which extreme probability outcomes are overweighted and low probability outcomes are underweighted
- φ controls how strongly differences in subjective values translate to a probability of choosing one option over the other



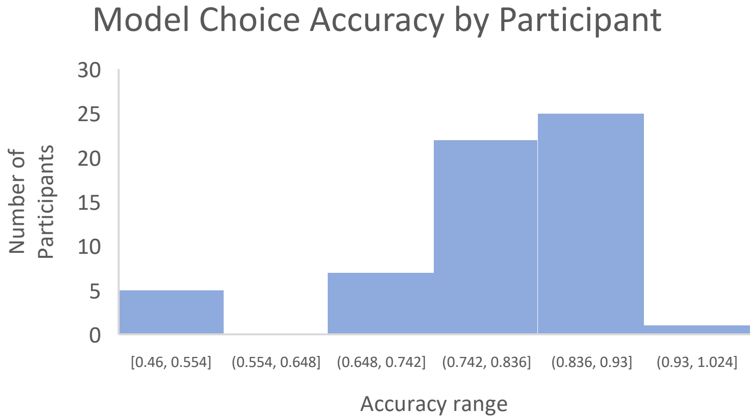
source: Chiu and Wu (2011)

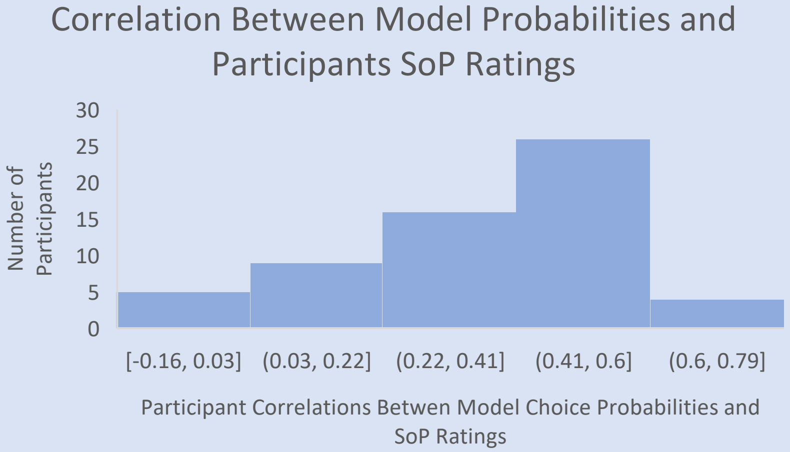
Subjective value of gamble = $\pi(\text{p}) * \text{z}^{\alpha}$

Probability of choosing gamble 2 = $1/[1 + e^{\varphi * Vgamble\,2 - Vgamble1}]$

Initial Fit:

- Implemented Bayesian CPT model in PyStan to fit α, γ, and φ individual parameters for each participant
- Model fit parameters predict gamble choices for each gamble pairing in the dataset with approximately 80% accuracy overall

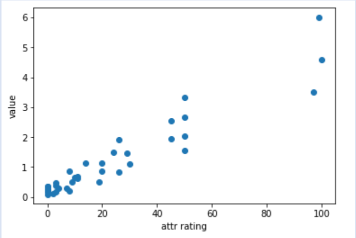




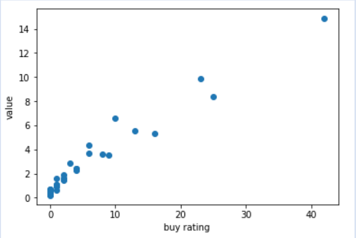
Evidence for Incorporating Strengths of Preferences into the Model

- Very significant correlations across participant strength of preference ratings and model value metrics

Illustrative Examples: Select Participant Correlations



Participant 49:
correlation between model subjective value and attractiveness rating = 0.95
study average: 0.70



Participant 19:
Correlation between model subjective value and buy rating = 0.97
study average = 0.80

Conclusions and Next Steps

- Significant information contained in SoP ratings, should be able to improve model performance
- Looking to understand best way to incorporate information
- Ex: should SoP ratings be incorporated on individual parameters in the model? or alongside choice probabilities and values?