Testing Theories of Investor Behavior Using Neural Data

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Introduction

- A growing body of research suggests investors make suboptimal financial decisions [1]
- One prominent example is the disposition effect: investors tend to sell more stocks that have gone in up value than stocks that have gone down in value, leading to lower average profits [2]
- Realization Utility (RU) can explain the disposition effect: subjects derive a positive hedonic impact from the act of selling a stock at a gain [3]
- We use fMRI to test the key assumption of this theory because it is difficult to test using only behavioral experiments or data from the field

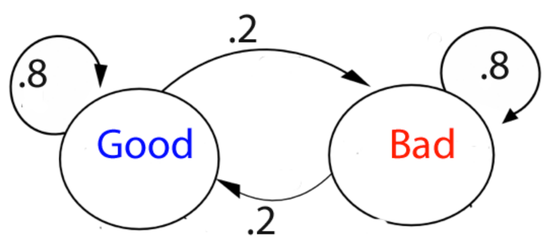
Hypotheses

1. Subjects will exhibit a disposition effect
2. At the time of decision, the vmPFC and vSt will encode the capital gain of the stock (decision value of selling)
3. Subjects with stronger vmPFC signal in response to a capital gain will exhibit a greater disposition effect
4. At the moment of selling a capital gain, there will be increased activity in the nucleus accumbens (RU signal)

Methods

- Subjects asked to trade in an experimental stock market while in the scanner, paid according to trading performance
- Three stocks: A, B & C, each of which followed the same stochastic process, known to the subject
- Subjects could hold a max of 1 share and a min of 0 shares
- In each trial (216 total), subjects saw a "price update" screen followed by a "decision" screen
  - Price update: new information displayed
  - Decision: no new information, *decision only*

Optimal Strategy

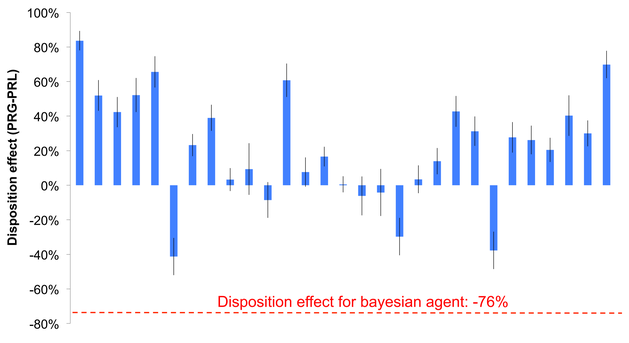


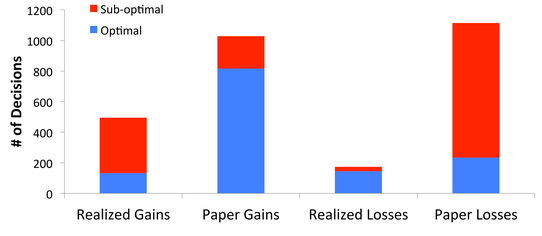
$$LORS = \log\frac{b_{t+1}(good \mid z)}{b_{t+1}(bad \mid z)} = \log\frac{\Pr(z \mid good)*[0.8*b_t(good)+0.2*b_t(bad)]}{\Pr(z \mid bad)*[0.8*b_t(bad)+0.2*b_t(good)]}$$

Optimal strategy: sell (or not buy) when LORS<0, buy or hold otherwise. This leads to the ***opposite*** of a disposition effect.

Behavioral Results

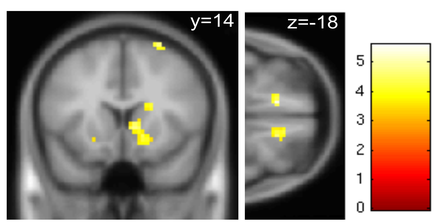
$$DE = \left(\frac{\#\text{ of realized gains}}{\#\text{ of realized gains} + \#\text{ of paper gains}}\right) - \left(\frac{\#\text{ of realized losses}}{\#\text{ of realized losses} + \#\text{ of paper losses}}\right)$$





Imaging Results

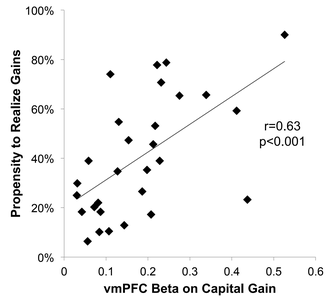
R1. vSt and vmPFC encode net capital gain at decision



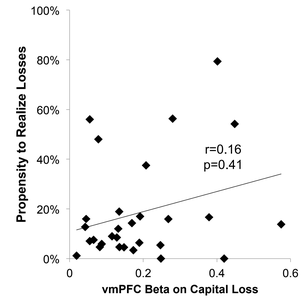
$$BOLD = \alpha + \beta_1 x_1 + \beta_2(\text{price-cost})*x_1 + \beta_3(bayesian)*x_1 + \beta_4 x_2 + \ldots + \beta_k x_k + e$$

x_1 := indicator of sell opportunity

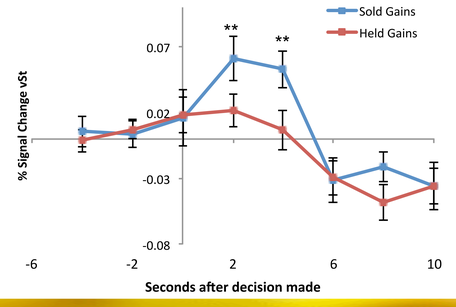
R2. vmPFC signal correlates with propensity to realize gains



R3. vmPFC signal does not correlate with propensity to realize losses



R4. NAcc distinguishes realized gains from paper gains



Conclusions

- Behaviorally, we find that subjects exhibit a large disposition effect, which is strongly suboptimal in our experiment
- The neural data are consistent with the realization utility hypothesis [3]
  - The vmPFC encodes capital gain (decision value of selling)
  - This signal is stronger for subjects who realize more gains
  - The NAcc exhibits increased activity when subjects realize a gain, relative to holding it
- Precise control over economic information coupled with neuroimaging allows us to:
  - Quantify suboptimal behavior
  - Test new economic theories
  - Obtain data central to a behavioral economic theory that is difficult to acquire otherwise

References

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3. Barberis, N. and Wei Xiong, Realization Utility, *Journal of Financial Economics,* forthcoming

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