Household Portfolio Underdiversification and Probability Weighting: Empirical Evidence

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Motivation

- Puzzling household portfolio choices:
  - Underdiversification
  - Skewness seeking
  - Investment in lottery-style stocks
- Difficult to explain using standard models with expected utility preferences
- Theoretical papers show that probability weighting can help explain portfolio choice puzzles
- Our paper: Household survey in which we elicit individual level measures of probability weighting and link these to portfolio choices

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Probability weighting

- Choices involving small probabilities are often difficult to explain under expected utility:
  - Buy both insurance and lottery tickets
  - Buy insurance for low value items (cell phone)
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EU versus Utility with probability weighting

Expected utility:

$$E(U) = \sum_{i=1}^{N} p_i U(c_i)$$

Utility with probability weighting:

$$V_{RDU} = \sum_{i=1}^{N} \pi_i U(c_i), \text{ where}$$

$$\pi_i = w(P_i) - w(P_{i-1})$$
$$= w(p_1 + p_2 + ... + p_i) - w(p_1 + p_2 + ... + p_{i-1})$$

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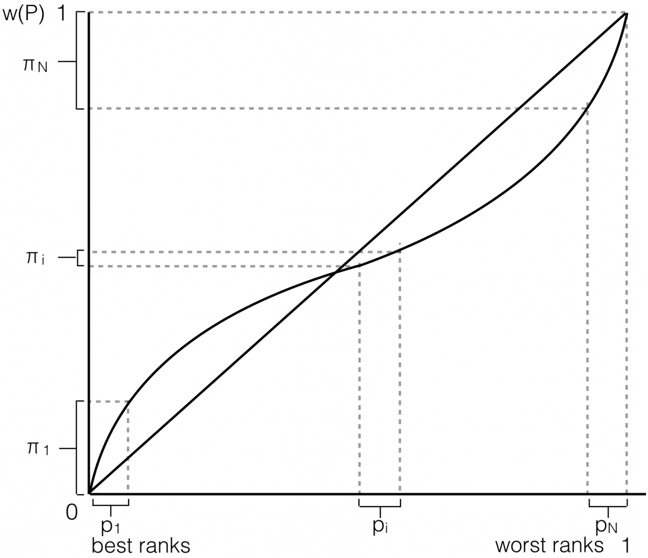
Inverse-S



Survey

- Conduct survey in RAND American Life Panel
- 2,702 U.S. households
- Internet based survey
- Purpose-built survey fielded June 20 to July 19, 2017
- Ages 18 to 70
- Real incentives for all our respondents (total payout $16,020)

Advantages of our approach

- Little direct evidence of influence probability weighting
- With lab experiments, difficult to link to economic behaviors outside the lab
(Rieger, 2012 and Erner, Klos, and Langer, 2013)
- With natural experiments or market data, difficult to separate beliefs from preferences
(market data: Polkovnichenko, 2005; Jullien and Salanié, 2000; Snowberg and Wolfers, 2010; Chiappori, Salanié, Salanié, and Gandhi; 2019 or
natural experiments: Sydnor, 2010; Barseghyan, Molinari, O'Donoghue, and Teitelbaum, 2013)
- Our paper: first to provide field evidence of a link between elicited probability weighting and decisions under risk

Elicitation method

- Adapted from decision science literature (Wakker and Deneffe, 1996; Abdellaoui, 2000)
- Simplified method due to time constraints of general population survey versus lengthy lab experiment
- No need to specify functional form for the probability weighting function

Survey question I

The payoff of Option A and Option B is determined by a draw of one ball from a box with 100 balls. Each ball in the box is either purple or orange. One ball will be drawn randomly from the box and its color determines the payoff you can win. For Option A, you win $42 if the ball drawn is purple (5% chance) and $6 if the ball drawn is orange (95% chance). For option B, you win $8 for sure (100% chance).

Option A	Option B
○ 5% chance of winning $42 95% chance of winning $6	○ 100% chance of winning $8

- Goal: Find sure amount that makes person indifferent between sure amount and lottery
- If choose Option A,we increase sure amount in Option B
- Three rounds, until indifference amount approximated
- Result: average sure amount = $8.30
- Expected value lottery is $7.80,
  so risk premium, $RP_{5\%}$ = (7.80-8.30)/8.30 = -6.5%

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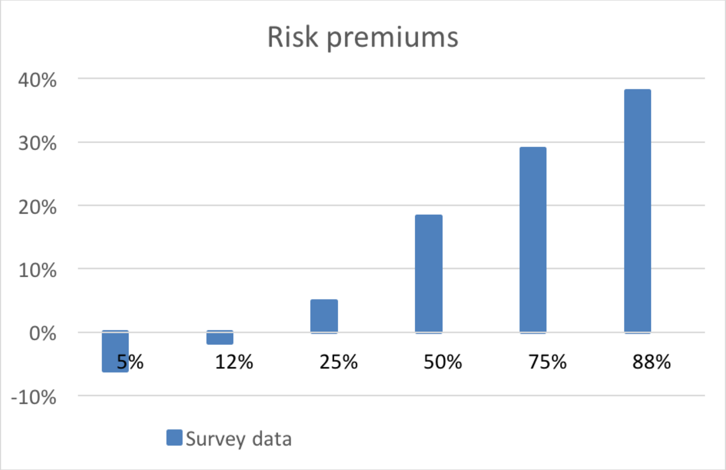
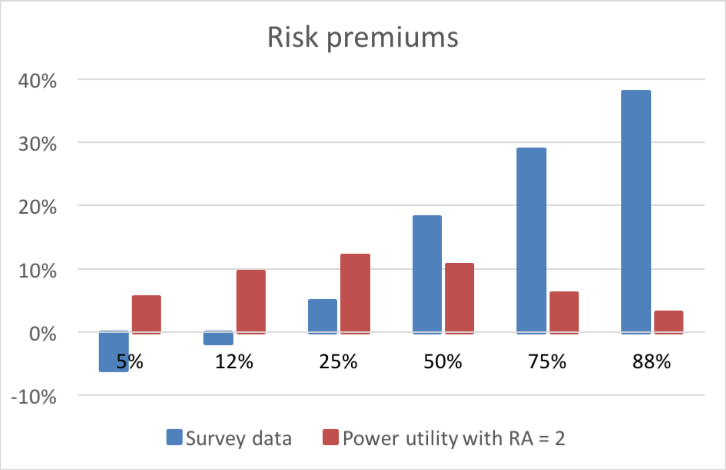
Risk premiums

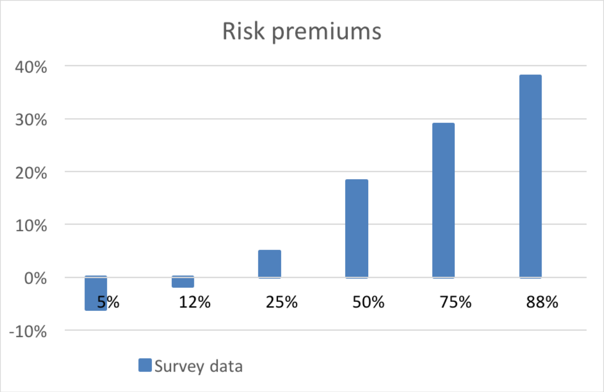


Risk premiums survey inconsistent with EU



- Assume no probability weighting, power utility with RA of 2, initial wealth of 100
- Risk premium pattern in survey data inconsistent with EU

Inverse-S



Probability weighting measure:

$$\textit{Inverse-S} = (RP_{88\%} + RP_{75\%} + RP_{50\%}) - (RP_{25\%} + RP_{12\%} + RP_{5\%})$$

- Risk premiums in the underweighting range minus premiums in the overweighting range
- Higher *Inverse-S* implies greater probability weighting
- With no probability weighting, *Inverse-S* should be approximately zero

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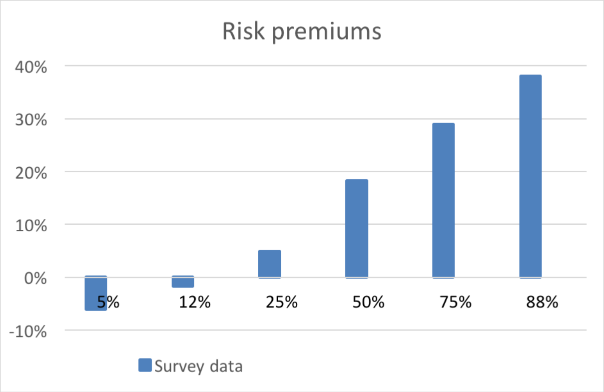

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Risk aversion (utility curvature)

The payoff of Option A and Option B is determined by a draw of one ball from a box with 100 balls. Each ball in the box is either purple or orange. One ball will be drawn randomly from the box and its color determines the payoff you can win. For Option A, you win $6 if the ball drawn is purple (33% chance) and $3 if the ball drawn is orange (67% chance). For option B, you win $12 if the ball drawn is purple (33% chance) and $0 if the ball drawn is orange (67%).

Option A	Option B
○ 33% chance of winning $6 67% chance of winning $3	○ 33% chance of winning $12 67% chance of winning $0

- 4 sets of questions to determine 4 risk premiums. Average risk premium is measure of risk aversion.

Other controls

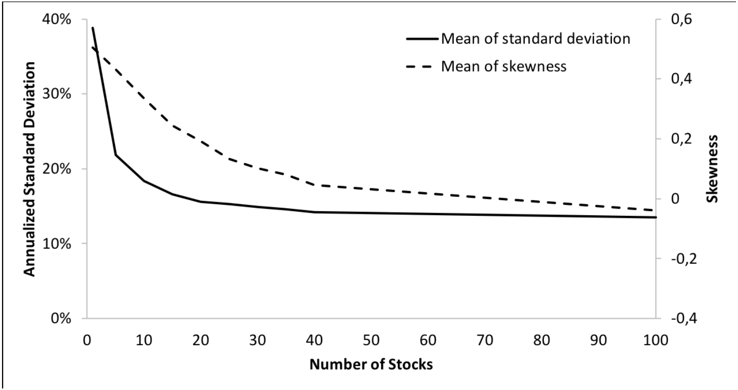
Controls: Numeracy, financial literacy, trust, optimism, age, female, married, white, Hispanic, number of household members, employment status, education, (ln) family income, and (ln) wealth

Correlations:

	Risk aversion	Optimism	Fin. literacy	Numeracy	Education
Inverse-S	0.094***	0.012	0.121***	0.106***	0.088*

Hypotheses

- Diversified stock portfolio is negatively skewed. Individual stock is positively skewed (Albuquerque, 2012; and Polkovnichenko, 2005).
- Probability weighting generates sensitivity to skewness



Hypotheses

- Hypothesis I:
  Inverse-S is *positively* related to *underdiversification*,
  as diversification erodes positive skewness

- Hypothesis II:
  Inverse-S is *positively* related to *skewness measures of individual company stock holdings*

Results: Underdiversification

- Dependent variable: $\frac{\text{individual stocks}}{\text{individual stocks + stock mutual funds}}$
- Good proxy for underdiversification (Calvet, Campbell, and Sodini; 2007, 2009).
  Own survey data: half of people holding individual stocks hold only 1 or 2 companies

	Fraction in Individual Stocks
Inverse-S	0.127**
	(2.454)
Full Controls	yes
Observations	741
Adj. R^2	0.050

- Magnitude: One stdev increase in *Inverse-S* results in 12.7 pp increase in the fraction of the equity portfolio allocated to individual stocks (28.7% relative to baseline of 45.0)

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- Respondents list names of 5 largest holdings
- Match names to CRSP
- Measure underdiversification: relative Sharpe ratio loss

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- Measure expected skewness of individual company stock holdings
- Analyses at the ***stock level***

	Total Skewness	Idiosyncratic Skewness	Max. One-Day Return	Idiosyncratic σ
	(1)	(2)	(3)	(4)
Inverse-S	0.111**	0.144***	0.006**	0.012*
	(2.524)	(2.742)	(2.297)	(1.767)
Full Controls	yes	yes	yes	yes
Observations	1,174	1,174	1,174	1,174
R^2	0.071	0.070	0.049	0.037

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	(2.094)	(2.702)	(1.816)	(1.372)
Full Controls	yes	yes	yes	yes
Observations	439	439	439	439
R^2	0.078	0.068	0.023	0.009

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Portfolio choice categories

Multinomial logit regression. The categories (in brackets expected relation with *Inverse-S*):

- Non-participation (+)
- Own individual stocks only (+)
- Own both individual stocks and equity mutual funds (+)
- Own equity mutual funds only (excluded category) (-)

	Non-Participation	Individual Stocks Only	Both Mutual Funds and Individual Stocks
	(1)	(2)	(3)
Inverse-S	0.289***	0.337**	0.273*
	(2.69)	(2.42)	(1.95)
Observations	2,671		
Adj. R^2	0.158		

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Robustness tests

Inverse-S measure does not capture probability unsophistication:

- Small *positive* correlation between Inverse-S and education, numeracy, and financial literacy
- Similar results for probability sophisticated subsets

Our results are robust to using parametric Inverse-S measures:

- Prelec
- Salience Theory
- Tversky & Kahneman

Our results are robust to measurement error in *Inverse-S*:

- Exclude respondents more than 3 errors
- Exclude respondents less than 90 seconds

Conclusion

- Elicit probability weighting preferences for a representative sample of U.S. households
- Test theory showing that probability weighting helps explain:
  - Underdiversification
  - Skewness seeking
  - Investment in lottery-style stocks
- Provides preference-based explanation for widespread finding that positively skewed stocks have low returns
- Shows importance probability weighting in decision making under risk