The Role of Intuition and Reasoning in Driving Aversion to Risk and Ambiguity

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October 5, 2012
When making a decision of minor importance, I have always found it advantageous to consider all the pros and cons. In vital matters however . . . the decision should come from the unconscious, from somewhere within ourselves.

—Sigmund Freud
• Attitudes towards risk and ambiguity are preference primitives central to almost all of economics.

• Typically, these two attitudes are studied separately as they are theoretically distinct.

• Empirically, however, several studies suggest risk and ambiguity aversion are positively correlated.
At the same time, a growing body of evidence documents the power of “intuitive” — rather than deliberative — decision making in various domains. For example …

• Bechara, et al. (1997): brain-damaged individuals with diminished emotional capacity but normal IQ and reasoning ability perform less well on an “Iowa Card Task” — a decision making task involving uncertainty.


• Important theorems in math are first stated intuitively (conjectures) and only later (sometimes after decades) after effortful reasoning formally proven.
Combining these two strands of research, we hypothesize that:

- reliance on intuition confers a comparative advantage in risky or uncertain situations.

- this advantage makes risk and uncertainty less aversive to intuitive thinkers.

- heterogeneity in reliance on intuition then provides one cognitive mechanism through which risk and ambiguity preferences are correlated.
Our Study

• We document a strong correlation between risk and ambiguity preferences in both a representative survey of Italian investors and separate experiments.

• We show that reliance on intuition is an economically and statistically significant predictor of both attitudes in both samples:
  o e.g., intuitive thinking associated with a 10 to 13 percentage point drop in likelihood of being ambiguity averse.

• We provide causal evidence by directly manipulating intuitive thinking and find even larger effects.

• We provide lab and field evidence that intuitive thinkers outperform others in highly uncertain situations.
Closely related literature

**Under-performance of deliberative thinking**
- Damasio (1994)
- Dijksterhuis (2004)

**Correlation between risk and ambiguity aversion**
- Burks, et al. (2008)
- Chakravarty and Roy (2006, 2009)
- Cohen et al., (2011)
- Lauriola and Levin (2001)
1. Unicredit Consumer Survey, 2007 (N=1686)
   - Representative of Italian Investors
   - Ellsberg question + Qualitative risk questions
   - *Merged with:* portfolio decisions around time of Lehman collapse

2. Main Experimental Data (N=1306)
   - Two separate experiments, conducted on-line
   - Potential monetary stakes: 20 - 40 euro (10% paid)
   - Students from Universities near Rome, Italy
   - Ambiguity elicitation + Risk aversion

3. Supplementary Experiments
   - Iowa Card Task, in-lab (N=168)
   - Causal evidence experiment (N=293)
Robustness and external validity

- **Survey**: heterogeneous and representative, but questions are hypothetical

- **Experiment**: less heterogeneous, but involves monetary incentives

- **Experimental results**: robustness w.r.t. monetary stakes for the survey

- **Survey results**: evidence for external validity of our main finding regarding performance of intuitive thinkers.
We measure thinking mode in multiple ways

**Survey:**
- Self-reported 3-category

**Main Experiments:**
- Self-reported 3-category
- Rational-Experiential Inventory (REI)
- Decision time*
Self-reported 3-category

“Think of when you make a decision. Generally speaking, do you tend to decide rather quickly relying mostly on your intuition or rather do you tend to think accurately about all possible alternatives and consequences of your choice, taking as much time as needed before reaching a final decision?”

- I decide very rapidly on the basis of my intuition;
- I partly ponder and partly rely on intuition;
- I ponder accurately, reasoning carefully about my choice.
Rational Experiential Inventory

- A psychological battery of 40 questions
- Measures experiential/intuitive engagement and rational/deliberative engagement as orthogonal constructs
- Not a perfect measure of the concept we are interested in, but related.
Time-to-decision

In the experiments, we exploit one fundamental difference between intuitive and deliberative thinking: decision speed.

We measure the time it takes participants to decide in our ambiguity elicitation questions, and from this create a 3-category measure of reliance on intuition.

- **Intuitive** = time < 33rd percentile (relatively fast)
- **Partially deliberative** = 33rd percentile ≤ time ≤ 66th percentile
- **Deliberative** = time > 66th percentile (relatively slow)
A brief aside:

• In the experiments, we rely on our behavioral (time-to-decision) measure of thinking mode.

• Why? Because we believe students are constantly primed to believe they are deliberative thinkers, coloring self-reported measures.

• Our behavioral measure does not suffer from such biases

However, it is worth noting that each of these measures is highly predictive of the other two, suggesting that they are all measuring a common phenomenon.
Risk preference measures

Survey
- Similar to US Survey of Consumer Finance measures
- Qualitative survey measure (Risk&Return combinations)
- Quantitative survey measure (Barsky et al)
- Both measure RRA

Experiments
- Holt & Laury implemented two ways
  - One row per screen (Experiment 1)
  - Table format (Experiment 2)
Ambiguity preference measures

Survey
- Hypothetical two-color Ellsberg urn question
  - choose a color, choose an urn

Main Experiments
  Experiment 1:
  - [Risky urn valuation] – [Ambiguous urn valuation]
    - Halevy (2007)
    - BDM mechanism used for each valuation
  Experiment 2:
  - Two-color, two choice, Ellsberg urn question
    - Urn choice for “win on red ball” bet
    - Urn choice for “win on white ball” bet
1. Correlation
2. Causation
3. Performance
Correlational Evidence
Result 1: Thinking mode predicts risk aversion and ambiguity aversion in the survey data
<table>
<thead>
<tr>
<th></th>
<th>Relative risk Aversion</th>
<th>Risk aversion</th>
<th>Ambiguity aversion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intuitive</td>
<td>-0.076 (0.084)</td>
<td>-0.099 (0.082)</td>
<td>-0.342** (0.096)</td>
</tr>
<tr>
<td>Deliberative</td>
<td>0.197** (0.062)</td>
<td>0.217** (0.059)</td>
<td>0.230** (0.068)</td>
</tr>
<tr>
<td>Age</td>
<td>0.006** (0.002)</td>
<td>0.006* (0.002)</td>
<td>-0.003 (0.003)</td>
</tr>
<tr>
<td>Male</td>
<td>-0.310** (0.064)</td>
<td>-0.308** (0.061)</td>
<td>0.104 (0.070)</td>
</tr>
<tr>
<td>Education</td>
<td>-0.026** (0.007)</td>
<td>-0.035** (0.007)</td>
<td>0.009 (0.008)</td>
</tr>
<tr>
<td>Married</td>
<td>-0.028 (0.063)</td>
<td>-0.035 (0.060)</td>
<td>0.161* (0.069)</td>
</tr>
<tr>
<td>North</td>
<td>0.129 (0.070)</td>
<td>-0.016 (0.068)</td>
<td>0.091 (0.078)</td>
</tr>
<tr>
<td>Centre</td>
<td>0.119 (0.080)</td>
<td>-0.016 (0.078)</td>
<td>0.201* (0.090)</td>
</tr>
<tr>
<td>City size</td>
<td>-0.164 (0.235)</td>
<td>-0.340 (0.234)</td>
<td>0.266 (0.274)</td>
</tr>
<tr>
<td>Log Household Wealth</td>
<td>-0.036 (0.028)</td>
<td>-0.099** (0.028)</td>
<td>0.134** (0.033)</td>
</tr>
<tr>
<td>Observations</td>
<td>1686</td>
<td>1686</td>
<td>1686</td>
</tr>
</tbody>
</table>

**Notes:** Each column shows a separate (ordered) probit estimate; *Intuitive* is a dummy equal to 1 if the investor relies mostly on intuition when making decisions (zero otherwise); *Deliberative* is a dummy equal to 1 if he relies mostly on reasoning (zero otherwise). The excluded group is those who partly rely on intuition partly on reasoning. Standard errors are reported in parenthesis.
Result 2: Thinking mode predicts risk aversion and ambiguity aversion in the experiment data
### Dependent variable = Risk aversion

<table>
<thead>
<tr>
<th></th>
<th>Experiment 1</th>
<th>Experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>Intuitive</td>
<td>-0.110**</td>
<td>-0.111***</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.032)</td>
</tr>
<tr>
<td>Deliberative</td>
<td>0.163***</td>
<td>0.084**</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.033)</td>
</tr>
<tr>
<td></td>
<td>-0.048**</td>
<td>0.283***</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.049)</td>
</tr>
<tr>
<td></td>
<td>-0.042</td>
<td>0.307***</td>
</tr>
<tr>
<td></td>
<td>(0.052)</td>
<td>(0.065)</td>
</tr>
</tbody>
</table>

- **Intuitive**: dummies for our behavioral thinking mode measure. The excluded category is “partially deliberative.”
- **Deliberative**: dummies for our behavioral thinking mode measure.

#### Demographic controls
- No
- Yes

#### Experiment design controls
- Yes
- Yes

#### Observations
- 534
- 486
- 772
- 692

### Notes:
Columns 1-4 estimate ordered probit models using risk aversion as the dependent variable. This measure is increasing in risk aversion. “Intuitive” and “Deliberative” are dummies for our behavioral thinking mode measure. The excluded category is “partially deliberative.” Demographics are: i) cognitive ability (participants’ score on a standardized math exam given in the final year of high school in Italy); ii) gender; iii) age; iv) parents’ total net income. “Experimental design controls” include dummies for the order in which the two versions of each risk and ambiguity elicitation methods were presented to subjects; in experiment 2 they were presented in the same order, so these controls are not applicable. Robust standard errors, clustered by session appear in parentheses.
<table>
<thead>
<tr>
<th>Experiment 1</th>
<th>Experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ambiguity Aversion</td>
</tr>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Intuitive</td>
<td>-0.373**</td>
</tr>
<tr>
<td></td>
<td>(0.152)</td>
</tr>
<tr>
<td>Deliberative</td>
<td>0.147*</td>
</tr>
<tr>
<td></td>
<td>(0.084)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.354*</td>
</tr>
<tr>
<td></td>
<td>(0.214)</td>
</tr>
<tr>
<td>Demographic controls</td>
<td>No</td>
</tr>
<tr>
<td>Experiment design controls</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>534</td>
</tr>
</tbody>
</table>

**Notes:** Each column presents a separate (ordered) probit model; “Intuitive” and “Deliberative” are dummies for our behavioral thinking mode measure. The excluded category is “partially deliberative.” Demographics are: i) cognitive ability (standardized math exam score); ii) gender; iii) age; iv) parents’ total net income. “Experimental design controls” include dummies for the order in which the two versions of each risk and ambiguity elicitation methods were presented to subjects; in experiment 2 they were presented in the same order, so these controls are not applicable. Robust standard errors, clustered by session appear in parentheses. **-11 pp**
Causal Evidence
Conducted on-line using US workers on Mechanical Turk ($1 “show-up” + 10% chance of experimental earnings)

Intuition manipulation (cf. Pham, Lee and Stephen, forthcoming):

“Please briefly describe [X] situations in which you relied on your intuition to make a decision and it turned out to be the correct thing to do.”

- High intuition treatment: \( X = 2 \)
- Low intuition treatment: \( X = 10 \)

After manipulation we measure risk and ambiguity preferences.
Causation Experiment

- Naming two such situations should be easy for most people and consequently should enhance their willingness to rely on their intuition;

- **Caveat**: the high intuition manipulation should have little effect on those who are already predisposed to rely on their intuition.

- REI scores in Experiments 1 & 2 suggest **women** are more likely than men to fit this description.

- We therefore expect a much weaker effect on women, and a much stronger effect on men.
Causation Experiment

- We use publicly verifiable and credible sources of risk and ambiguity to construct bets on subsets of \{0,1,...,9\}.
  - 3\textsuperscript{rd} draw in California (Mid-Day) Daily 3 lottery
  - Tenth’s digit of Sacramento, CA temperature

- Risk tolerance measure: certainty equivalent of a 50/50 \+$10, -$0 bet elicited using Becker-DeGroot-Marschak mechanism

- 3-category ambiguity tolerance measure: two urn, two choice, Ellsberg question using events:
  - \( L = \{1, 3, 4, 7, 9\} \); and
  - \( R = \{0, 2, 5, 6, 8\} \)
Result 3: Intuitive thinking causes lower risk and ambiguity aversion among men; we find no effect of our manipulation on women.

• 30 percentage point increase in probability of being ambiguity tolerant

• 30 percent decrease in CE of 50/50 +$10, -$0 gamble.
<table>
<thead>
<tr>
<th></th>
<th>(1) Female only</th>
<th>(2) Female only</th>
<th>(3) Male only</th>
<th>(4) Male only</th>
<th>(5) Male only</th>
<th>(6) Male only</th>
<th>(7) Male only</th>
<th>(8) Male only</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ambig tolerance</strong></td>
<td>-0.05</td>
<td>-0.04</td>
<td>-0.25</td>
<td>-0.31</td>
<td>0.76**</td>
<td>0.80**</td>
<td>2.12***</td>
<td>1.97**</td>
</tr>
<tr>
<td><strong>(3-cat)</strong></td>
<td>(0.29)</td>
<td>(0.30)</td>
<td>(0.61)</td>
<td>(0.62)</td>
<td>(0.32)</td>
<td>(0.37)</td>
<td>(0.74)</td>
<td>(0.78)</td>
</tr>
<tr>
<td><strong>Risk tolerance</strong></td>
<td>-0.04</td>
<td>-0.25</td>
<td>0.76**</td>
<td>0.80**</td>
<td>0.76**</td>
<td>0.80**</td>
<td>2.12***</td>
<td>1.97**</td>
</tr>
<tr>
<td><strong>(continuous)</strong></td>
<td>(0.30)</td>
<td>(0.61)</td>
<td>(0.62)</td>
<td>(0.74)</td>
<td>(0.32)</td>
<td>(0.37)</td>
<td>(0.74)</td>
<td>(0.78)</td>
</tr>
<tr>
<td><strong>High Intuition treatment</strong></td>
<td>6.08***</td>
<td>8.29***</td>
<td>3.68**</td>
<td>7.12**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>(0.95)</td>
<td>(2.48)</td>
<td>(1.58)</td>
<td>(2.96)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Controls</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demographic</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Time of day</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Exp. features</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td><strong>Obs</strong></td>
<td>187</td>
<td>185</td>
<td>187</td>
<td>185</td>
<td>106</td>
<td>106</td>
<td>106</td>
<td>106</td>
</tr>
<tr>
<td><strong>R-squared</strong></td>
<td>0.11</td>
<td>0.12</td>
<td>0.23</td>
<td>0.30</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Columns 1, 2, 5 and 6 present ordered probit estimates, while columns 3, 4, 7 and 8 report OLS estimates. “High intuition treatment” is an indicator variable for the manipulation was designed to confidence in intuition. “Ambig tolerance” is a 3-category variable increasing in ambiguity tolerance: it takes the value 0 if the participant is ambiguity averse, 1 if neither ambiguity averse nor ambiguity seeking and 2 if ambiguity seeking. “Risk tolerance” is a continuous variable increasing in risk tolerance: the participant’s certainty equivalent for a 50/50 gain $10, lose $0 gamble elicited in an incentive compatible manner.
Performance in uncertain environments

Survey Data

• Pace at which individuals exited the market (sold stocks) just before and after the Lehman collapse

Experimental Data (N=168)

• Performance on “Iowa Gambling Task”
• Randomly-invited subset of participants from main experiments
• Conducted in-lab, all participants paid
Iowa Card Task

• Four (computerized) card decks

• Participants’ only instruction is to maximize their earnings

• The participants do not know:
  • 2 of the decks yield positive expected earnings (good)
  • 2 of the decks yield negative expected earnings (bad)
  • The game ends on the 100th draw

• Participants are not allowed to quit before 100 draws, even if they are earning negative money

• Truly negative earnings not likely because of show-up fee and, indeed, never happened.
Result 4: Intuitive thinkers perform better in the Iowa Card Task
Iowa Card Task

Thinking mode labels are from Experiment 1 or Experiment 2 data
Iowa Card Task

- There is no performance difference between deliberative and partially deliberative thinkers
- On all blocks of 10 draws, on average intuitive thinkers drew from 3% to 10% more cards from good decks than non-intuitive thinkers
- Over 100 card draws, the performance advantage of intuitive thinkers was about 7%, which is statistically significant (p<0.01; OLS)
- This advantage remains when controlling for all available demographics
Stock market exits

- We link our UCS survey data with a panel of administrative data detailing respondents’ financial portfolios.

- Data are available at a monthly frequency starting in December 2006 until October 2009. Thus, they cross the Great Recession.

- For each of 26 asset classes we know the value of each individual’s holdings at the end of each month and the net flow in each month. Because we observe the net assets flows we can identify net trades.
Stock market exits

- We consider market timing in the months preceding the collapse of Lehman Brothers, a situation involving substantial Knightian uncertainty.

- With benefit of hindsight, selling before the collapse was obviously a better decision than selling after the collapse.

- If intuitive ability confers an advantage in such situations, we would expect intuitive stockholders to exit the market before the collapse of Lehman Brothers at a faster pace.
Result 5: Intuitive thinkers timed their stock market exit better than non-intuitive thinkers. I.e., they sold stocks at a higher rate just before the Lehman collapse.
In 17 of the 21 months before Lehman collapse (vertical bar), intuitive thinkers were more likely to sell stocks (conditional on holding stocks).
Concluding Remarks

- Theoretically, risk and ambiguity aversion are independent traits. Empirically, however, they seem to be positively correlated.

- This raises the obvious question of “why”? We provide, to our knowledge, the first study directly addressing this important question.

- We propose a novel explanation based on the comparative advantage of intuitive thinking in uncertain situations.

- We provide both correlational and causal evidence on the explanatory power of intuitive thinking for risk and ambiguity preferences.

- We also provide evidence on the comparative advantage intuitive thinking conveys in risky and uncertain situations.
Stock market exits

• In the paper, we show formally that in the months prior to the Lehman collapse, intuitive stockholders were significantly more likely to sell their stocks and that this difference vanishes after the collapse.

• The patterns are so evident that we can also see them graphically, by plotting the difference in the proportion of intuitive stockholders selling stocks and deliberative stockholders selling stocks, over time.

• We find that in 17 of the 21 months before the Lehman collapse (vertical bar), intuitive stockholders were more likely to sell stocks than deliberative stockholders.