Testing for Ambiguity in Coordination Games

David Kelsey
Department of Economics, University of Exeter, England

Sara LeRoux
Department of Economics, Oxford Brookes University

University of Exeter.

September 2014
Ambiguity refers to types of uncertainty for which it is difficult or impossible to determine the relevant probabilities.
INTRODUCTION

- Ambiguity refers to types of uncertainty for which it is difficult or impossible to determine the relevant probabilities.

- A large experimental literature has shown that ambiguity is an important influence on decision-making.
Ambiguity refers to types of uncertainty for which it is difficult or impossible to determine the relevant probabilities.

A large experimental literature has shown that ambiguity is an important influence on decision-making.

However most of this literature concerns single person decisions. There are relatively few experiments which test for ambiguity in games.
INTRODUCTION

- Ambiguity refers to types of uncertainty for which it is difficult or impossible to determine the relevant probabilities.
- A large experimental literature has shown that ambiguity is an important influence on decision-making.
- However most of this literature concerns single person decisions. There are relatively few experiments which test for ambiguity in games.
- In the present paper we test how ambiguity affects behaviour in games.
Ambiguity refers to types of uncertainty for which it is difficult or impossible to determine the relevant probabilities.

A large experimental literature has shown that ambiguity is an important influence on decision-making.

However most of this literature concerns single person decisions. There are relatively few experiments which test for ambiguity in games.

In the present paper we test how ambiguity affects behaviour in games.

Games provide a link to economic models.
INTRODUCTION

- Ambiguity refers to types of uncertainty for which it is difficult or impossible to determine the relevant probabilities.
- A large experimental literature has shown that ambiguity is an important influence on decision-making.
- However most of this literature concerns single person decisions. There are relatively few experiments which test for ambiguity in games.
- In the present paper we test how ambiguity affects behaviour in games.
- Games provide a link to economic models.
- In games subjects create ambiguity for one another rather than the experimenter creating ambiguity.
We find strong evidence of ambiguity-aversion in games.
We find strong evidence of ambiguity-aversion in games.

Equilibrium Under Ambiguity (EUA see Eichberger, Kelsey, and Schipper (2009)) predicts play in these games better than Nash equilibrium or iterated dominance.
Results Summary

- We find strong evidence of ambiguity-aversion in games.
- Equilibrium Under Ambiguity (EUA see Eichberger, Kelsey, and Schipper (2009)) predicts play in these games better than Nash equilibrium or iterated dominance.
- Ambiguity has a larger impact in games than in urn experiments.
We find strong evidence of ambiguity-aversion in games.

Equilibrium Under Ambiguity (EUA see Eichberger, Kelsey, and Schipper (2009)) predicts play in these games better than Nash equilibrium or iterated dominance.

Ambiguity has a larger impact in games than in urn experiments.

Ambiguity-attitudes appear to be context dependent. Attitudes in games tend to differ from ambiguity-attitudes in urn experiments.
Ambiguity Theory

We use the neo-additive model of ambiguity, axiomatised by Chateauneuf, Eichberger, and Grant (2007). They represent preferences by:

$$\alpha \delta M(a) + \delta (1 - \alpha) m(a) + (1 - \delta) E_\pi u(a),$$

(1)

- $M(a)$ denotes the maximum utility of act $a$,
- $m(a)$ denotes the minimum utility of act $a$,
- $E_\pi u(a)$ denotes the expected utility of act $a$.

This is a special case of the Choquet expected utility model, Schmeidler (1989), which represents beliefs as capacities.
Ambiguity Theory

We use the neo-additive model of ambiguity, axiomatised by Chateauneuf, Eichberger, and Grant (2007). They represent preferences by:

$$\alpha \delta M(a) + \delta (1 - \alpha) m(a) + (1 - \delta) E_{\pi} u(a),$$  \hspace{1cm} (1)

- $M(a)$ denotes the maximum utility of act $a$,
- $m(a)$ denotes the minimum utility of act $a$,
- $E_{\pi} u(a)$ denotes the expected utility of act $a$.  

This is a special case of the Choquet expected utility model, Schmeidler (1989), which represents beliefs as capacities.

- $\delta$ is a measure of perceived ambiguity;
We use the neo-additive model of ambiguity, axiomatised by Chateauneuf, Eichberger, and Grant (2007). They represent preferences by:

\[ \alpha \delta M(a) + \delta (1 - \alpha) m(a) + (1 - \delta) E_{\pi} u(a), \tag{1} \]

- \( M(a) \) denotes the maximum utility of act \( a \),
- \( m(a) \) denotes the minimum utility of act \( a \),
- \( E_{\pi} u(a) \) denotes the expected utility of act \( a \).

This is a special case of the Choquet expected utility model, Schmeidler (1989), which represents beliefs as capacities.

- \( \delta \) is a measure of perceived ambiguity;
- \( \alpha \) measures ambiguity-attitude, \( \alpha = 1 \) (resp. \( \alpha = 0 \)) corresponding to pure optimism (resp. pessimism).
We use the neo-additive model of ambiguity, axiomatised by Chateauneuf, Eichberger, and Grant (2007). They represent preferences by:

$$\alpha \delta M(a) + \delta (1 - \alpha) m(a) + (1 - \delta)E_{\pi}u(a),$$  \hspace{1cm} (1)

- $M(a)$ denotes the maximum utility of act $a$,
- $m(a)$ denotes the minimum utility of act $a$,
- $E_{\pi}u(a)$ denotes the expected utility of act $a$.

This is a special case of the Choquet expected utility model, Schmeidler (1989), which represents beliefs as capacities.

- $\delta$ is a measure of perceived ambiguity;
- $\alpha$ measures ambiguity-attitude, $\alpha = 1$ (resp. $\alpha = 0$) corresponding to pure optimism (resp. pessimism).
- Only 2 additional parameters needed compared to expected utility.
The Games

Player 2

\[
\begin{array}{c|ccc}
\text{Player 1} & \text{L} & \text{M} & \text{R} \\
\hline
\text{T} & 0,0 & 300,100 & 50, x \\
\text{B} & 100,300 & 0,0 & 55, x \\
\end{array}
\]

\[x = 230, 120, 200, 170, 260, 60 \text{ (in that order).}\]

This is the familiar Battle of the Sexes game modified by adding an extra secure option for player 2.

We believe subjects are likely to perceive ambiguity in the Battle of the Sexes since.

- It has two pure strategy Nash equilibria.
The Games

Player 2

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>M</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>0, 0</td>
<td>300, 100</td>
<td>50, $x$</td>
</tr>
<tr>
<td>B</td>
<td>100, 300</td>
<td>0, 0</td>
<td>55, $x$</td>
</tr>
</tbody>
</table>

$x = 230, 120, 200, 170, 260, 60$ (in that order).

This is the familiar Battle of the Sexes game modified by adding an extra secure option for player 2.

We believe subjects are likely to perceive ambiguity in the Battle of the Sexes since.

- It has two pure strategy Nash equilibria.
- Our experiments were one shot.
Nash Equilibrium

Theorem

The game has the following Nash equilibria:

1. When $0 \leq x \leq 75$, there are 3 equilibria: $\langle T, M \rangle$, $\langle B, L \rangle$ and $\langle \frac{1}{4} T + \frac{3}{4} B, \frac{1}{4} L + \frac{3}{4} M \rangle$.

2. When $75 < x < 100$, there are 3 equilibria: $\langle T, M \rangle$, $\langle B, L \rangle$ and $\langle D \rangle$.

3. When $100 < x < 300$, there is a unique equilibrium: $\langle B, L \rangle$, which also satisfies iterated deletion of dominated strategies.
Theorem

The game has the following Nash equilibria:

1. When $0 \leq x \leq 75$, there are 3 equilibria: $\langle T, M \rangle$, $\langle B, L \rangle$ and $\langle \frac{1}{4} T + \frac{3}{4} B, \frac{1}{4} L + \frac{3}{4} M \rangle$.
   
   Note $R$ is dominated by the mixed strategy $\frac{1}{4} L + \frac{3}{4} M$.

2. When $75 < x < 100$, there are 3 equilibria: $\langle T, M \rangle$, $\langle B, L \rangle$ and $\langle D_x 100 T + (100 - x) 100 B, \frac{1}{4} M + \frac{3}{4} R \rangle$.

3. When $100 < x < 300$, there is a unique equilibrium: $\langle B, L \rangle$, which also satisfies iterated deletion of dominated strategies.
Theorem

The game has the following Nash equilibria:

1. When $0 \leq x \leq 75$, there are 3 equilibria: $\langle T, M \rangle$, $\langle B, L \rangle$ and $\langle \frac{1}{4} T + \frac{3}{4} B, \frac{1}{4} L + \frac{3}{4} M \rangle$.
   
   Note $R$ is dominated by the mixed strategy $\frac{1}{4} L + \frac{3}{4} M$.

2. When $75 < x \leq 100$, there are 3 equilibria: $\langle T, M \rangle$, $\langle B, L \rangle$ and $\langle \frac{x}{100} T + \frac{100-x}{100} B, \frac{1}{61} M + \frac{60}{61} R \rangle$. 
The game has the following Nash equilibria:

1. When $0 \leq x \leq 75$, there are 3 equilibria: $\langle T, M \rangle$, $\langle B, L \rangle$, and $\langle \frac{1}{4} T + \frac{3}{4} B, \frac{1}{4} L + \frac{3}{4} M \rangle$.

   Note $R$ is dominated by the mixed strategy $\frac{1}{4} L + \frac{3}{4} M$.

2. When $75 < x \leq 100$, there are 3 equilibria: $\langle T, M \rangle$, $\langle B, L \rangle$, and

   $\langle \frac{x}{100} T + \frac{100-x}{100} B, \frac{1}{61} M + \frac{60}{61} R \rangle$.

3. When $100 < x < 300$, there is a unique equilibrium: $\langle B, L \rangle$, which also satisfies iterated deletion of dominated strategies.
Theorem

The game has the following Equilibria under Ambiguity:

1. When $0 \leq x \leq (1 - \delta)75$, there are 3 equilibria: $\langle T, M \rangle$, $\langle B, L \rangle$ and $\langle \frac{1}{4} T + \frac{3}{4} B, \frac{1}{4} L + \frac{3}{4} M \rangle$.

2. When $(1 - \delta)75 < x < (1 - \delta)100$, there are 3 equilibria: $\langle T, M \rangle$, $\langle B, L \rangle$ and $\langle D_x(1 - \delta)100 T + (1 - \delta)100 x, 1 \frac{6}{101} M + 60 \frac{6}{101} R \rangle$.

3. When $(1 - \delta)100 < x < (1 - \delta)300$, there is a unique equilibrium: $\langle B, L \rangle$.

4. When $x > (1 - \delta)300$, there is a unique equilibrium: $\langle B, R \rangle$.

If $\delta = \frac{1}{2}$, then (1) occurs for $0 \leq x \leq 37\frac{5}{6}$.

(2) occurs for $37\frac{5}{6} < x < 50\frac{1}{6}$.

(3) occurs for $50\frac{1}{6} < x < 150\frac{5}{6}$.

(4) occurs for $150\frac{5}{6} < x$.

The estimate $\delta = \frac{1}{2}$ comes from Kilka and Weber 2001.
Theorem

The game has the following Equilibria under Ambiguity:

1. When \( 0 \leq x \leq (1 - \delta)75 \), there are 3 equilibria: \( \langle T, M \rangle \), \( \langle B, L \rangle \) and 
\( \left\langle \frac{1}{4} T + \frac{3}{4} B, \frac{1}{4} L + \frac{3}{4} M \right\rangle \).

2. When \((1 - \delta)75 < x \leq (1 - \delta)100\), there are 3 equilibria: 
\( \langle T, M \rangle \), \( \langle B, L \rangle \) and 
\( \left\langle \frac{x}{(1-\delta)100} \cdot T + \frac{[(1-\delta)100-x]}{(1-\delta)100} \cdot B, \frac{1}{61} \cdot M + \frac{60}{61} \cdot R \right\rangle \).
Theorem

The game has the following Equilibria under Ambiguity:

1. When $0 \leq x \leq (1 - \delta)75$, there are 3 equilibria: $\langle T, M \rangle$, $\langle B, L \rangle$ and $\langle \frac{1}{4}T + \frac{3}{4}B, \frac{1}{4}L + \frac{3}{4}M \rangle$.

2. When $(1 - \delta)75 < x \leq (1 - \delta)100$, there are 3 equilibria: $\langle T, M \rangle$, $\langle B, L \rangle$ and $\langle \frac{x}{(1-\delta)100} \cdot T + \frac{[(1-\delta)100-x]}{(1-\delta)100} \cdot B, \frac{1}{61} \cdot M + \frac{60}{61} \cdot R \rangle$.

3. When $(1 - \delta)100 < x < (1 - \delta)300$, there is a unique equilibrium: $\langle B, L \rangle$.
The game has the following Equilibria under Ambiguity:

1. When \( 0 \leq x \leq (1 - \delta)75 \), there are 3 equilibria: \( \langle T, M \rangle, \langle B, L \rangle \) and \( \left\langle \frac{1}{4}T + \frac{3}{4}B, \frac{1}{4}L + \frac{3}{4}M \right\rangle \).

2. When \( (1 - \delta)75 < x \leq (1 - \delta)100 \), there are 3 equilibria: \( \langle T, M \rangle, \langle B, L \rangle \) and \( \left\langle \frac{x}{(1 - \delta)100} \cdot T + \frac{[(1 - \delta)100 - x]}{(1 - \delta)100} \cdot B, \frac{1}{61} \cdot M + \frac{60}{61} \cdot R \right\rangle \).

3. When \( (1 - \delta)100 < x < (1 - \delta)300 \), there is a unique equilibrium: \( \langle B, L \rangle \).

4. When \( x > (1 - \delta)300 \), there is a unique equilibrium: \( \langle B, R \rangle \).
Equilibrium Under Ambiguity (EUA)

Theorem

The game has the following Equilibria under Ambiguity:

1. When $0 \leq x \leq (1 - \delta)75$, there are 3 equilibria: $\langle T, M \rangle, \langle B, L \rangle$ and $\langle \frac{1}{4} T + \frac{3}{4} B, \frac{1}{4} L + \frac{3}{4} M \rangle$.

2. When $(1 - \delta)75 < x \leq (1 - \delta)100$, there are 3 equilibria: $\langle T, M \rangle, \langle B, L \rangle$ and $\left( \frac{x}{(1-\delta)100} \cdot T + \frac{[(1-\delta)100-x]}{(1-\delta)100} \cdot B, \frac{1}{61} \cdot M + \frac{60}{61} \cdot R \right)$.

3. When $(1 - \delta)100 < x < (1 - \delta)300$, there is a unique equilibrium: $\langle B, L \rangle$.

4. When $x > (1 - \delta)300$, there is a unique equilibrium: $\langle B, R \rangle$.

If $\delta = \frac{1}{2}$, then (1) occurs for $0 \leq x \leq 37.5$. (2) occurs for $37.5 < x \leq 50$. (3) occurs for $50 < x < 150$. (4) occurs for $x > 150$. The estimate $\delta = \frac{1}{2}$, comes from Kilka and Weber 2001.
Theorem

The game has the following Equilibria under Ambiguity:

1. When $0 \leq x \leq (1 - \delta)75$, there are 3 equilibria: $\langle T, M \rangle, \langle B, L \rangle$ and $\langle \frac{1}{4} T + \frac{3}{4} B, \frac{1}{4} L + \frac{3}{4} M \rangle$.

2. When $(1 - \delta)75 < x \leq (1 - \delta)100$, there are 3 equilibria: $\langle T, M \rangle, \langle B, L \rangle$ and $\langle \frac{x}{(1-\delta)100} \cdot T + \frac{[(1-\delta)100-x]}{(1-\delta)100} \cdot B, \frac{1}{61} \cdot M + \frac{60}{61} \cdot R \rangle$.

3. When $(1 - \delta)100 < x < (1 - \delta)300$, there is a unique equilibrium: $\langle B, L \rangle$.

4. When $x > (1 - \delta)300$, there is a unique equilibrium: $\langle B, R \rangle$.

If $\delta = \frac{1}{2}$, then (1) occurs for $0 \leq x \leq 37.5$. (2) occurs for $37.5 \leq x \leq 50$, (3) occurs for $50 \leq x \leq 150$. (4) occurs for $150 \leq x$.

The estimate $\delta = \frac{1}{2}$, comes from Kilka and Weber 2001.
Experimental Predictions

<table>
<thead>
<tr>
<th></th>
<th>Player 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>0, 0</td>
</tr>
<tr>
<td>M</td>
<td>300, 100</td>
</tr>
<tr>
<td>R</td>
<td>50, x</td>
</tr>
<tr>
<td>T</td>
<td>100, 300</td>
</tr>
<tr>
<td>B</td>
<td>0, 0</td>
</tr>
</tbody>
</table>

\[ x = 60, 120, 170, 200, 230, 260. \]

- By choosing \( R \) player 1 is able to protect himself/herself against ambiguity.
By choosing $R$ player 1 is able to protect himself/herself against ambiguity.

- If we use $\delta = \frac{1}{2}$, then $R$ is part of an EUA for $x = 60, 170, 200, 230, 260$. 
Experimental Predictions

<table>
<thead>
<tr>
<th>Player 1</th>
<th>Player 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>L</td>
</tr>
<tr>
<td>T</td>
<td>0, 0</td>
</tr>
<tr>
<td>B</td>
<td>100, 300</td>
</tr>
</tbody>
</table>

\[ x = 60, 120, 170, 200, 230, 260. \]

- By choosing \( R \) player 1 is able to protect himself/herself against ambiguity.
- If we use \( \delta = \frac{1}{2} \), then \( R \) is part of an EUA for \( x = 60, 170, 200, 230, 260. \)
- Nash equilibrium predicts \( R \) is not chosen for any of these values of \( x. \)
Experimental Predictions

Player 2

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>M</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>0, 0</td>
<td>300, 100</td>
<td>50, x</td>
</tr>
<tr>
<td>B</td>
<td>100, 300</td>
<td>0, 0</td>
<td>55, x</td>
</tr>
</tbody>
</table>

\( x = 60, 120, 170, 200, 230, 260. \)

- By choosing \( R \) player 1 is able to protect himself/herself against ambiguity.
- If we use \( \delta = \frac{1}{2} \), then \( R \) is part of an EUA for \( x = 60, 170, 200, 230, 260. \).
- Nash equilibrium predicts \( R \) is not chosen for any of these values of \( x \).
- Iterated dominance predicts \( R \) is not chosen for \( x = 120, 170, 200, 230, 260. \).
Experimental Predictions

<table>
<thead>
<tr>
<th></th>
<th>$L$</th>
<th>$M$</th>
<th>$R$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T$</td>
<td>0, 0</td>
<td>300, 100</td>
<td>50, $x$</td>
</tr>
<tr>
<td>$B$</td>
<td>100, 300</td>
<td>0, 0</td>
<td>55, $x$</td>
</tr>
</tbody>
</table>

$x = 60, 120, 170, 200, 230, 260.$

- By choosing $R$, player 1 is able to protect himself/herself against ambiguity.
- If we use $\delta = \frac{1}{2}$, then $R$ is part of an EUA for $x = 60, 170, 200, 230, 260$.
- Nash equilibrium predicts $R$ is not chosen for any of these values of $x$.
- Iterated dominance predicts $R$ is not chosen for $x = 120, 170, 200, 230, 260$.
- For $x = 60$, $R$ is dominated by the mixed strategy $\frac{3}{4}M + \frac{1}{4}L$ which yields an expected return of 75.
We performed some experiments based on the 3-ball Ellsberg urn.

<table>
<thead>
<tr>
<th>Act</th>
<th>30 balls</th>
<th>60 balls</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Red</td>
<td>Blue</td>
</tr>
<tr>
<td>$f$</td>
<td>$y$</td>
<td>0</td>
</tr>
<tr>
<td>$g$</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>$h$</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

For $y = 95, 90, 80$, subjects were given the choice of betting on blue or yellow.
For $y = 100$, subjects were given two choices as in the classic Ellsberg experiment.

- A computer simulated the draw of the ball.
Experimental Design

- 80 subjects. from St. Stephen’s College, Delhi, and University of Exeter.
- Paper and pencil.
- Subjects were randomly allocated role of Column Player/Row Player.
- 11 rounds - Battle of Sexes alternated with an Ellsberg Urn problem.
- Once choices were made: Random game and Random Ellsberg Urn round chosen to determine payment.
- Average payment: Indian subjects = Rs.420 (£6 approx.) Exeter subjects = £7.40.
There is strong evidence that ambiguity-aversion affects choice. Strategy $R$ is chosen very frequently.

In cases $x = 120, 170, 200, 230, 260$, strategy $R$ is chosen even though both Nash equilibrium and iterated dominance say that it should not.

In the case $x = 60, 30\%$ of subjects choose $R$, even though it is dominated by a mixed strategy.

Row players appear to randomise 50:50.

There was no significant effect of: gender, location, i.e. Exeter or Delhi, degree programme, i.e. arts or science. (Economics students were not used as subjects.)
Results: Games

- There is strong evidence that ambiguity-aversion affects choice. Strategy $R$ is chosen very frequently.

- In cases $x = 120, 170, 200, 230, 260$, strategy $R$ is chosen even though both Nash equilibrium and iterated dominance say that it should not be.
There is strong evidence that ambiguity-aversion affects choice. Strategy $R$ is chosen very frequently.

In cases $x = 120, 170, 200, 230, 260$, strategy $R$ is chosen even though both Nash equilibrium and iterated dominance say that it should not be.

In the case $x = 60$, 30% of subjects choose $R$, even though it is dominated by a mixed strategy.
There is strong evidence that ambiguity-aversion affects choice. Strategy $R$ is chosen very frequently.

In cases $x = 120, 170, 200, 230, 260$, strategy $R$ is chosen even though both Nash equilibrium and iterated dominance say that it should not be.

In the case $x = 60$, 30% of subjects choose $R$, even though it is dominated by a mixed strategy.

Row players appear to randomise 50:50.
Results: Games

- There is strong evidence that ambiguity-aversion affects choice. Strategy $R$ is chosen very frequently.
- In cases $x = 120, 170, 200, 230, 260$, strategy $R$ is chosen even though both Nash equilibrium and iterated dominance say that it should not be.
- In the case $x = 60$, 30% of subjects choose $R$, even though it is dominated by a mixed strategy.
- Row players appear to randomise 50:50.
- There was no significant effect of:

Gender, Location, i.e. Exeter or Delhi, degree programme, i.e. arts or science. (Economics students were not used as subjects.)
There is strong evidence that ambiguity-aversion affects choice. Strategy $R$ is chosen very frequently.

In cases $x = 120, 170, 200, 230, 260$, strategy $R$ is chosen even though both Nash equilibrium and iterated dominance say that it should not be.

In the case $x = 60$, 30% of subjects choose $R$, even though it is dominated by a mixed strategy.

Row players appear to randomise 50:50.

There was no significant effect of:

- Gender,
There is strong evidence that ambiguity-aversion affects choice. Strategy $R$ is chosen very frequently.

In cases $x = 120, 170, 200, 230, 260$, strategy $R$ is chosen even though both Nash equilibrium and iterated dominance say that it should not be.

In the case $x = 60$, 30% of subjects choose $R$, even though it is dominated by a mixed strategy.

Row players appear to randomise 50:50.

There was no significant effect of:

- Gender,
- Location, i.e. Exeter or Delhi,
Results: Games

- There is strong evidence that ambiguity-aversion affects choice. Strategy $R$ is chosen very frequently.
- In cases $x = 120, 170, 200, 230, 260$, strategy $R$ is chosen even though both Nash equilibrium and iterated dominance say that it should not be.
- In the case $x = 60$, 30% of subjects choose $R$, even though it is dominated by a mixed strategy.
- Row players appear to randomise 50:50.
- There was no significant effect of:
  - Gender,
  - Location, i.e. Exeter or Delhi,
  - degree programme, i.e. arts or science. (Economics students were not used as subjects.)
Results of Urn Experiments

- When $y = 100$:
  - 46% of subjects displayed ambiguity-aversion.
  - 9% of subjects displayed ambiguity-preference.
  - Less ambiguity-aversion than in most previous experiments.
  - Due to computer simulation?
  - Less ambiguity-aversion than in the game experiments.

- When $y = 80$, 30% of subjects chose $R$, thus displaying strong ambiguity-aversion.

Correlation between ambiguity-attitude in games and urn experiments is low.
Results of Urn Experiments

- When $y = 100$:
  - 46% of subjects displayed ambiguity-aversion.
Results of Urn Experiments

- When $y = 100$:
  - 46% of subjects displayed ambiguity-aversion.
  - 9% of subjects displayed ambiguity-preference.

Less ambiguity-aversion than in most previous experiments.
Due to computer simulation?
Less ambiguity-aversion than in the game experiments.
When $y = 80$, 30% of subjects chose $R$, thus displaying strong ambiguity-aversion.
Correlation between ambiguity-attitude in games and urn experiments is low.
Results of Urn Experiments

- When $y = 100$:
  - 46% of subjects displayed ambiguity-aversion.
  - 9% of subjects displayed ambiguity-preference.

- Less ambiguity-aversion than in most previous experiments.
Results of Urn Experiments

- When $y = 100$:
  - 46% of subjects displayed ambiguity-aversion.
  - 9% of subjects displayed ambiguity-preference.
- Less ambiguity-aversion than in most previous experiments.
  - Due to computer simulation?
Results of Urn Experiments

- When $y = 100$:
  - 46% of subjects displayed ambiguity-aversion.
  - 9% of subjects displayed ambiguity-preference.

- Less ambiguity-aversion than in most previous experiments.
  - Due to computer simulation?

- When $y = 80$, 30% of subjects chose $R$, thus displaying strong ambiguity-aversion.

Correlation between ambiguity-attitude in games and urn experiments is low.
Results of Urn Experiments

- When \( y = 100 \):
  - 46% of subjects displayed ambiguity-aversion.
  - 9% of subjects displayed ambiguity-preference.

- Less ambiguity-aversion than in most previous experiments.
  - Due to computer simulation?

- Less ambiguity-aversion than in the game experiments.
Results of Urn Experiments

- When $y = 100$:
  - 46% of subjects displayed ambiguity-aversion.
  - 9% of subjects displayed ambiguity-preference.

- Less ambiguity-aversion than in most previous experiments.
  - Due to computer simulation?

- Less ambiguity-aversion than in the game experiments.
Results of Urn Experiments

- When $y = 100$:
  - 46% of subjects displayed ambiguity-aversion.
  - 9% of subjects displayed ambiguity-preference.

- Less ambiguity-aversion than in most previous experiments.
  - Due to computer simulation?

- Less ambiguity-aversion than in the game experiments.

- When $y = 80$, 30% of subjects chose $R$, thus displaying strong ambiguity-aversion.
Results of Urn Experiments

- When $y = 100$:
  - 46% of subjects displayed ambiguity-aversion.
  - 9% of subjects displayed ambiguity-preference.

- Less ambiguity-aversion than in most previous experiments.
  - Due to computer simulation?

- Less ambiguity-aversion than in the game experiments.

- When $y = 80$, 30% of subjects chose $R$, thus displaying strong ambiguity-aversion.

- Correlation between ambiguity-attitude in games and urn experiments is low.
Ambiguity affects play in games.
Ambiguity affects play in games.

There is more ambiguity-aversion in games than in urn experiments.
Ambiguity affects play in games.

There is more ambiguity-aversion in games than in urn experiments.

Subjects perceive the urn as less ambiguous. For instance they can assign probabilities by the principal of insufficient reason.
Ambiguity affects play in games.

There is more ambiguity-aversion in games than in urn experiments.

Subjects perceive the urn as less ambiguous. For instance they can assign probabilities by the principal of insufficient reason.

Less ambiguity aversion than in previous Ellsberg urn experiments.
Ambiguity affects play in games.
There is more ambiguity-aversion in games than in urn experiments.
Subjects perceive the urn as less ambiguous. For instance they can assign probabilities by the principal of insufficient reason.
Less ambiguity aversion than in previous Ellsberg urn experiments.
Ambiguity affects play in games.

There is more ambiguity-aversion in games than in urn experiments.

Subjects perceive the urn as less ambiguous. For instance they can assign probabilities by the principal of insufficient reason.

Less ambiguity aversion than in previous Ellsberg urn experiments.

Lo (1996) presents an alternative theory of ambiguity in games. For games with only pure strategy Nash equilibrium Lo’s solution concept coincides with Nash equilibrium.

Dow and Werlang (1994) theory of ambiguity in games provides a better explanation of our evidence than Lo’s theory.


