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David Kelsey (University of Exeter.)
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Contest Model

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- The prize is worth $V$ to both players.
- Each contestant $i = A, B$ chooses an expenditure or effort level, $x_i \in X_i = [\kappa V, \lambda V]$, where $\kappa < \frac{1}{4}$ and $\lambda > \frac{1}{4}$.
- The probability that individual $A$ will win the contest is given by:

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Contestant $A$’s utility function:

$$u_A(x_A, x_B) = \frac{x_A}{x_A + x_B} V - x_A.$$
Nash Equilibrium

Player A’s utility is given by

\[ u_A (x_A, x_B) = \frac{x_A}{x_A + x_B} V - x_A. \]

One can derive A’s best response function which is:

\[ x_A = \sqrt{Vx_B} - x_B. \]

The best response function has the following properties:

- it is inverse U-shaped, (single peaked);
- the peak occurs where it crosses the 45° line;
- it is above (resp. below) the 45° line before (resp. after) the peak;
- There is a unique Nash equilibrium where \( x_A^* = x_B^* = \frac{V}{4} \);
- half of the rent is dissipated in Nash equilibrium.
Figure: Reaction function

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Contests with Ambiguity
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Ambiguity is represented by assigning a set of probabilities to an event, e.g. the probability of winning the war is between 0.5 and 0.7.
The Neo-additive Model of Ambiguity

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

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

- \( M(a) \) denotes the maximum utility of act \( a \),
- \( m(a) \) denotes the minimum utility of act \( a \),
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- This is a special case of the Choquet expected utility model, Schmeidler (1989), which represents beliefs as capacities.
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- Only 2 additional parameters needed compared to expected utility.
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Ambiguity in Contests

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The other major influence on behaviour is the intensity of competition. If one’s opponents are providing similar effort levels competition is intense, which increases the incentive to provide effort.
We start by considering a symmetric contest. The prize has the same value, $V$, for both players.
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Equilibrium effort is a decreasing function of the degree of ambiguity.
Symmetric Equilibrium

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- Equilibrium effort is a decreasing function of the degree of ambiguity.
- It takes the value \( x_A = x_B = \frac{V}{4} \) when there is no ambiguity and \( x_A = x_B = \left( \sqrt{\lambda} - \lambda \right) V \) when there is maximal ambiguity.
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Proposition

Assume $\delta_A = \delta_B = \hat{\delta} > 0$ and $\alpha_A = \alpha_B = \hat{\alpha}$. Then:

1. a symmetric equilibrium exists and is unique;
2. there is less effort than in Nash equilibrium;
3. the equilibrium effort level, $\hat{x}$, is a strictly decreasing function of $\hat{\delta}$.
Increasing ambiguity

\( x_B \)

\( R_A \)

\( \frac{V}{4} \)

\( x_B \)
Ambiguity-Attitude

The effect of a change in ambiguity-attitude is summarised by the following result.

**Proposition**

Consider the symmetric case where $\delta_A = \delta_B = \hat{\delta}$ and $\alpha_A = \alpha_B = \hat{\alpha}$ then an increase in ambiguity-aversion $\hat{\alpha}$ will reduce equilibrium effort provided $\lambda \kappa V^2 - \hat{x}^2 > 0$.

**Remark**

Suppose that $\kappa \geq \frac{1}{16 \lambda}$, then $\lambda \kappa V^2 - \hat{x}^2 \geq \frac{V^2}{16} - \hat{x}^2 > 0$ since $x_A < \frac{V}{4}$ by Proposition 4.1. Henceforth we shall assume $X_A = X_B = [\kappa V, \lambda V]$, where $\lambda > \frac{1}{4}$, $\frac{1}{4} > \kappa \geq \frac{1}{16 \lambda}$.

Thus an increase in optimism (ambiguity-loving) usually leads to higher effort.

An decrease in $\alpha$ shifts decision weight from the worst outcome to the best outcome.

The inequality $\kappa \geq \frac{1}{16 \lambda}$ implies that the best case is not too good.
Continue to assume the prize has the same value for both players.

However we allow for asymmetric perceptions of ambiguity $\delta_A \neq \delta_B$ and different ambiguity-attitudes $\alpha_A \neq \alpha_B$.

With ambiguity both players provide less than the Nash equilibrium level of effort.

This is a possible explanation of why rent dissipation is not complete.

**Proposition**

Assume that both players perceive ambiguity, $1 \geq \delta_A > 0, 1 \geq \delta_B > 0$. Then in equilibrium both will make less than the Nash equilibrium level of contributions.

This result is not true if the value of winning is different for the two players, $V_A \neq V_B$. 
Assume the players are initially in a symmetric equilibrium and there is an increase in the ambiguity perceived by Player B. Then in equilibrium both players will provide less effort. More ambiguity causes Player B to put more weight on the possibility that his opponent will play a high strategy. This decreases B’s perceived marginal benefit. Player A responds by reducing her effort, since the competition from B has become less intense.

Proposition

Let $\tilde{x}_A = \tilde{x}_B = \tilde{\delta}$, $\tilde{\alpha}_A = \tilde{\alpha}_B = \tilde{\alpha}$, if $x_0 A, x_0 B$ denotes the equilibrium effort levels when $\delta_A = \tilde{\delta} < \delta_B = \tilde{\delta}$, then:

1. $x_0 B < \tilde{x}_B$,
2. $x_0 A < \tilde{x}_A$,
3. $x_0 A > x_0 B$. 

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Comparative Statics of Ambiguity I

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1. $x'_B < \tilde{x}_B$,
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$B$ perceives more ambiguity
Comparative Statics of Ambiguity II

- Starting at a symmetric equilibrium assume that Player A perceives less ambiguity.
- This causes A’s equilibrium effort to rise.
- Players B’s effort will fall since the competition from A has become less intense. The competition is now biased in A’s favour, which reduces B’s marginal benefit of effort.

**Proposition**

Let \( \hat{x}_A = \hat{x}_B = \hat{x} \) denote the equilibrium effort levels when \( \delta_A = \delta_B = \hat{\delta} \), \( \alpha_A = \alpha_B = \hat{\alpha} \). If \( \langle x'_A, x'_B \rangle \) denotes the equilibrium effort levels when \( \delta_A = \tilde{\delta} < \delta_B = \hat{\delta}, \alpha_A = \alpha_B = \hat{\alpha} \). Then:

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A perceives less ambiguity

\(R_B\)

\(R_A\)

\(R'_A\)
Suppose you could choose your ambiguity-attitude. Which ambiguity-attitude should you choose?

Equivalently supposing instead of playing the game yourself you can appoint an agent to play it for you. What is the best ambiguity-attitude for such an agent to have?

Assuming that you are initially behind, you should choose an agent who is rather more ambiguity-averse than you are.

Recall Fudenberg and Tirole have decomposed the consequences of appointing an agent into a strategic effect and a direct effect. By the envelope theorem the direct effect is negligible for small changes. A more ambiguity-averse agent will provide less effort than you would. This has the strategic advantage of inducing your rival to expend less effort, which has a positive effect on your payoff.
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The comparative statics of ambiguity in contests is predictable, despite the fact that contests do not exhibit strategic complementarity.
Conclusion

- In the presence of ambiguity rent dissipation is less than 100%.
- Most general comparative static results assume strategic complementarity, e.g. Milgrom and Roberts, Econometrica 1990.
- The comparative statics of ambiguity in contests is predictable, despite the fact that contests do not exhibit strategic complementarity.
- Directions for future research.
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Directions for future research.

- Other behavioural biases, e.g. overconfidence, loss aversion.
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Directions for future research.

- Other behavioural biases, e.g. overconfidence, loss aversion.
- Can the results be generalised to a larger class of games, e.g. all games of aggregate externalities where marginal benefit is single peaked?