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Owner-Intruder Contests with Information Asymmetry

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Owner-Intruder Contests

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Introduction

- In nature, kleptoparasitism, the stealing of resources, occurs across species including insects, birds, fish, and mammals.
- We consider kleptoparasitic interactions between two individuals - Owner and Intruder. The Owner is in a possession of a resource when it spots Intruder. The Owner has to decide whether to defend the resource. If the Owner defends, the Intruder has to decide whether to fight with the Owner.
- We determine under what conditions should they fight over a resource.
- The conditions also depend on three distinct information cases:
  - Full information: the Owner and Intruder know the resource values for themselves and each other.
  - Partial information: the Owner and Intruder only know the resource value for themselves.
  - No Information: the Owner and Intruder do not know the resource values for themselves and each other.

Mathematical model

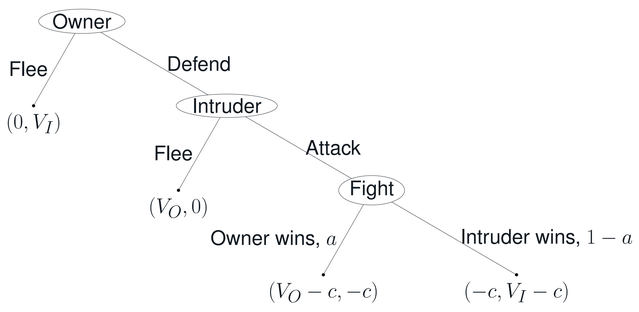

Fig. 1: Scheme and payoffs of the Owner-Intrude game. In the terminal nodes, (P_O, P_I) means payoffs to the Owner and Intruder. The game is solved by backward induction.

Notation	Meaning
V_I	Value of the resource for the Intruder
V_O	Value of the resource for the Owner
c	Cost of the fight
a	Probability of the Owner winning the fight
π_I	Probability that the Intruder will attack; $\pi_I = Prob\left(\frac{c}{1-a} < V_I\right)$
π_O	Probability that the Owner will defend; $\pi_O = Prob\left(\frac{c}{a} < V_O\right)$
$P_O^{\text{Info case}}$	Payoff to the Owner in the given information case
$P_I^{\text{Info case}}$	Payoff to the Intruder in the given information case
$E[V]$	Expected value of the resource for the Owner or Intruder

Table 1: Summary of the notation.

Results

Behavior and Payoffs Owner	Intruder	Full information	Partial information	No information
Defends V_O	Flees 0	$\frac{c}{1-a} > V_I$	any V_O $\frac{c}{1-a} > V_I$	$\frac{\pi_I c}{1-(1-a)\pi_I} < V_O$	$\frac{c}{1-a} > E[V_I]$
Defends $aV_O - c$	Attacks $(1-a)V_I - c$	$\frac{c}{1-a} < V_I$ $\frac{c}{a} < V_O$	$\frac{c}{1-a} < V_I$	$\frac{\pi_I c}{1-(1-a)\pi_I} < V_O$	$\frac{c}{1-a} < E[V_I]$ $\frac{c}{a} < E[V_O]$
Flees 0	Takes over V_I	$\frac{c}{1-a} < V_I$ $\frac{c}{a} > V_O$	any V_I	$\frac{\pi_I c}{1-(1-a)\pi_I} > V_O$	$\frac{c}{1-a} < E[V_I]$ $\frac{c}{a} > E[V_O]$

Table 2: Summary of behavioral outcomes and payoffs.

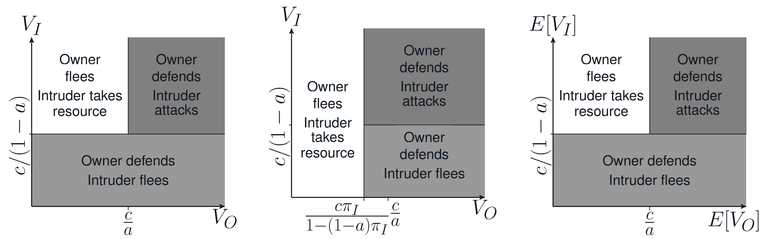

Fig. 2: Behavioral outcomes of the game for the different information cases. The payoffs depend on the behavior of the Owner and Intruder and are as follows: 1) when Owner defends and Intruder flees: $P_O = V_O$, $P_I = 0$, 2) when Owner defends and Intruder attacks: $P_O = aV_O - c$, $P_I = (1-a)V_I - c$, 3) when Owner flees and Intruder takes the resource: $P_O = 0$, $P_I = V_I$.

Left: Full information case. Center: Partial information case. Right: No information case

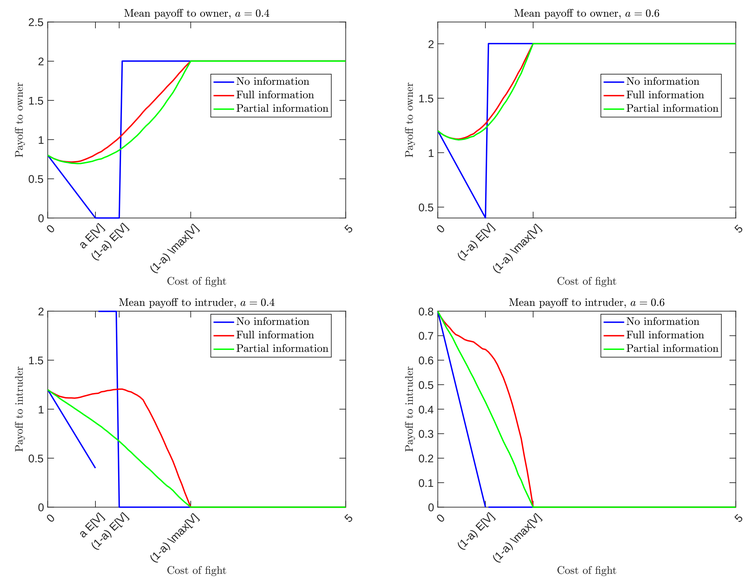

Fig. 3: Mean payoffs to the Owner (top) and Intruders (bottom) under different information cases. Here c varies, V_O and V_I are drawn from the uniform distribution on $(0, 4)$ and $a = 0.4$ (left) or $a = 0.6$ (right).

Changing the order of players

- In the full information and the no information case, the order of players matters only for small values of V_O and V_I.
- The individual deciding first has an advantage - it bluffs by pretending to be ready to fight; the fight is too costly for the other individual to call the bluff.
- In the partial information case, there are four regions where the order matters.

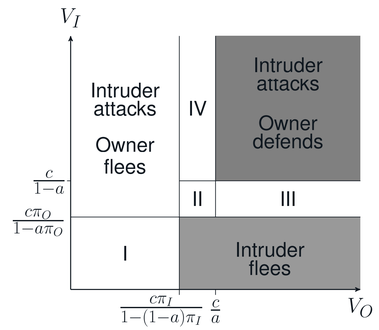

Fig. 4: Partial information case - the effect of the order of the decisions. Region I: The second individual has an advantage. Region II: The first individual has the advantage. Region III: It is better for the Owner to go first and for the Intruder to go second. Region IV: It is better for the Intruder to go first and for the Owner to go second.

Conclusions

- The actual fights occur only when the cost of the fight is relatively low compared to the resource value. This is in an agreement with previous experiments.
- Under most circumstances, it is beneficial for the individual to know more rather than to know less.
- However, the no information case is sometimes best for the Owner (because the Intruder will flee and not fight).
- Increasing the opponent's knowledge may be helpful in some instances and detrimental in others.
- The order of players matters - going first is better in most circumstances, but going second is sometimes best in the partial information case.

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