Game Theory
&
the Evolution of Cooperation

Course 5

Open Collaboration and Peer Production
(i290m)


Ceci n'est pas une pipe.
Magritte

Prisoner's Dilemma

		Column Player	
		Cooperate	Defect
Row Player	Cooperate	*R = 3 , R = 3*	*S = 0 , T = 5*
	Defect	*T = 5 , S = 0*	*P = 1 , P = 1*

R : reward

T : temptation

P : punishment

S : sucker

T > R > P > S

Game properties :

Communication is "cheap"

only commitment count (i.e. played game)

Nash equilibrium : Defect - Defect

embodies fundamental selfishness of biological and human entities in nature

Computer Tournaments (late 1970s)

Tournament 1

14 strategy submissions + RANDOM = 15 strategies

played pairwise : 225 rounds

Submissions from

psychology, sociology

political science, economics

computer science, mathematics

Winner :

TIT FOR TAT

Lessons from Tournament 1

Rules :

1. be nice at first (unlike DOWNING)

2. retaliate immediately (TIT FOR TAT)

3. forgive (e.g. TIT FOR TAT, TIT FOR TWO TATS)

Observations :

1. Strategies were two competitive

2. Some strategies could have outperformed Tit for Tat

(e.g. Downing, Tit for Two Tat)

Computer Tournaments

Tournament 2

63 strategies

3969 pairwise games

Results & analysis of Tournament 1 were known !

Winner :

TIT FOR TAT *again !*

Lessons from Tournament 2

1. Be nice and forgiving,

2. If others are going to be nice and forgiving,

it pays to try to take advantage of them

$\Rightarrow$ **Second lesson was exploitative of the first !**

TIT FOR TAT

nice, retaliation, forgiveness

(like for Tournament 1)

+ clarity !

Evolutionary Perspective

Observation

Strategies have mutated between Tournaments !

Question

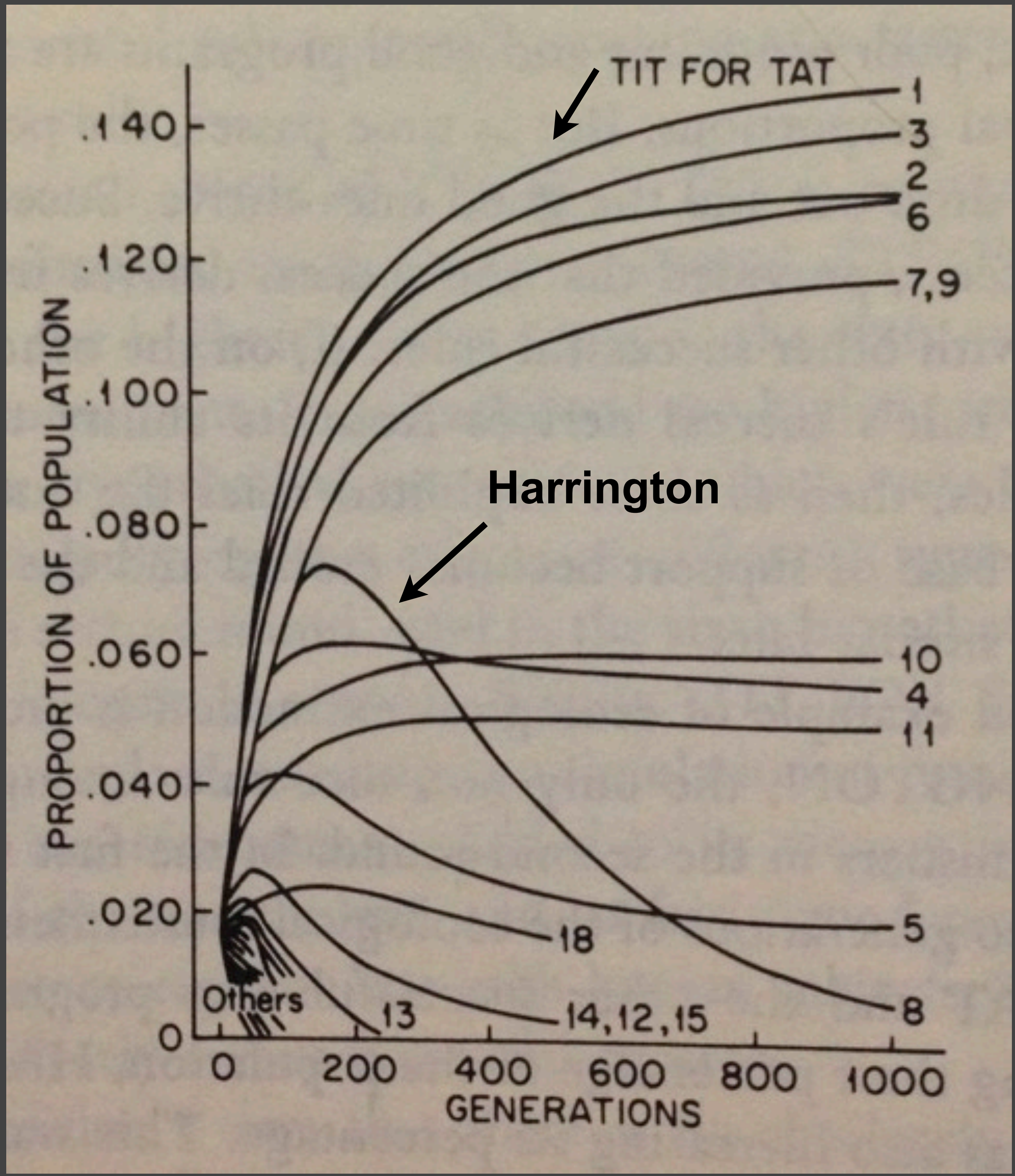
Does this strategy resist any kind of environment ?

actually

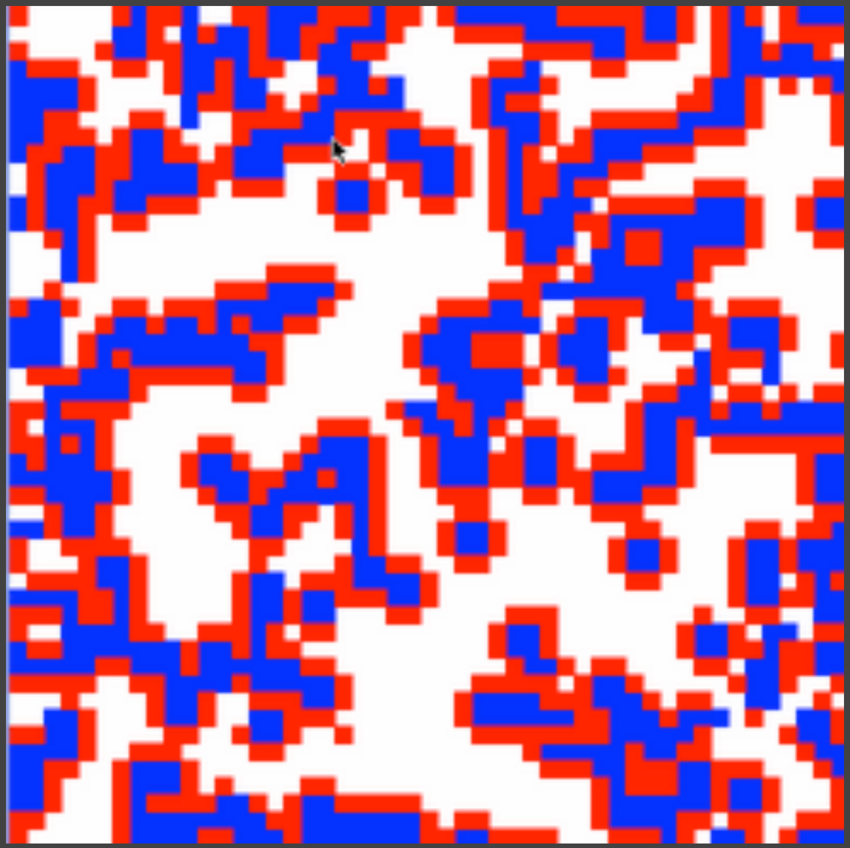
TIT FOR TAT

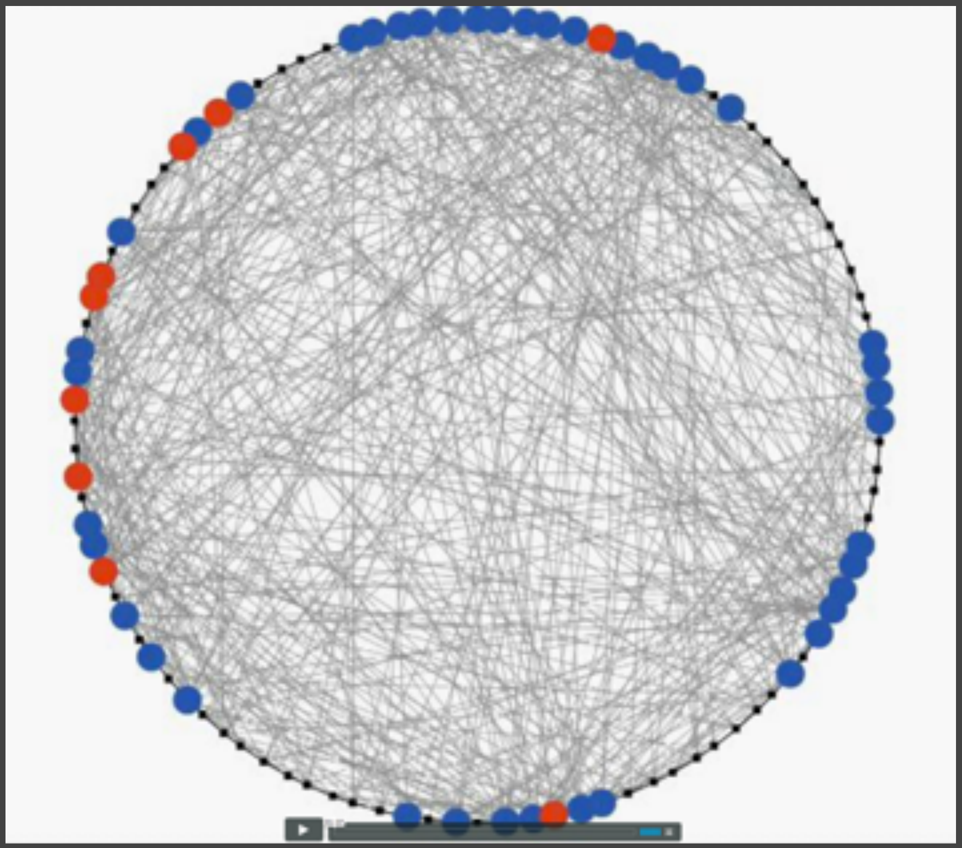
performs best with low discount rate (i.e. w close to 1)

Evolutionary Perspective



The Emergence of Cooperation





Dirk Helbing and Wenjian Yu, The outbreak of cooperation among success-driven individuals under noisy conditions." Proceedings of the National Academy of Sciences, Vol. 106, No. 8, Feb. 23, 2009.

Application of Game Theory to Open Collaboration

Article 1 (today)

Initiating private-collective innovation:

The fragility of knowledge sharing

(Simon Gächter, Georg von Krogh, Stefan Haefliger)

Article 2 (11/15)

The architecture of participation: Does code architecture mitigate free riding in the open source development model?

(Baldwin, C. Y. & Clark, K. B.)

Incentives to Innovate

Private investment model

innovators privately fund innovation

Collective action model

public subsidies + non-rivalry + non-exclusivity

Private-collective model

innovators privately fund public good innovations

The Fragility of Knowledge Sharing : Initiation

retain intellectual property rights
(patent, trade secrets) and keep exclusive rights

or

share knowledge as a public good

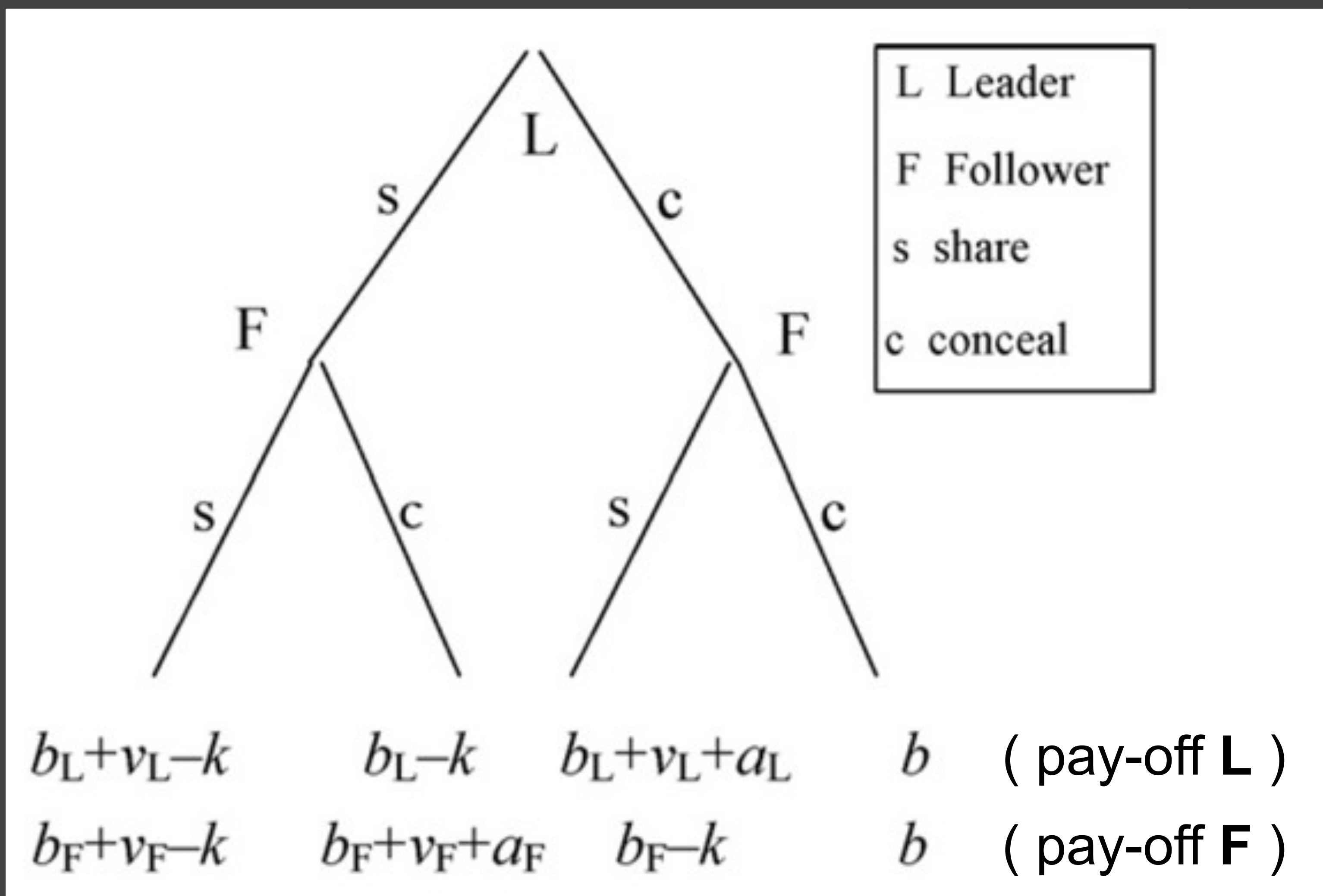
Under many circumstances, the innovator's incentive to conceal rather than to share knowledge is strong.

Assumptions

1. Knowledge sharing enhances value for the party that receives the knowledge.

2. Mutual knowledge sharing makes knowledge public and precludes the exclusivity of received knowledge for one's own private financial benefit. By implication, a necessary (but not sufficient) condition for exclusive appropriation is unilateral knowledge sharing.

The Knowledge Sharing Game



b_i : base pay-off

v_i : value from sharing

a_i : exclusivity pay-off

k : expense for sharing

Game with multiple equilibria

Proposition 1

Knowledge sharing based on rationality and self-interest

1. *Mutual concealment is always an equilibrium outcome*

2. *A necessary condition for mutual sharing*
as an equilibrium outcome is that $a_F = 0$
A necessary and sufficient condition for sharing
in all subgames is that exclusivity payoffs
are zero for both players ($a_L = a_F = 0$)

3. *In all constellations of exclusivity payoffs*
$(aL \geq 0) \times (aF \geq 0)$,
there always exist equilibria with unilateral knowledge sharing

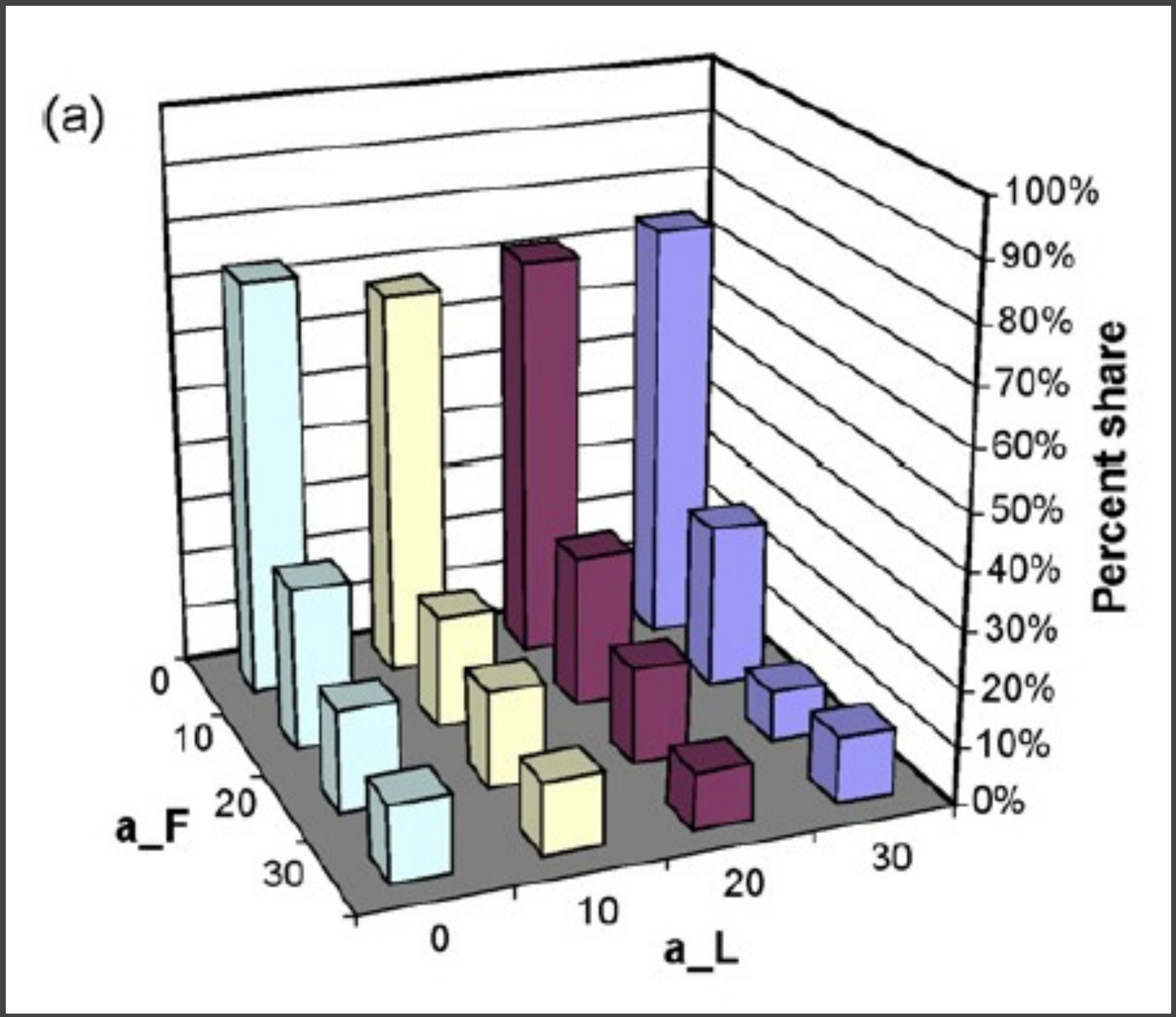
Proposition 2

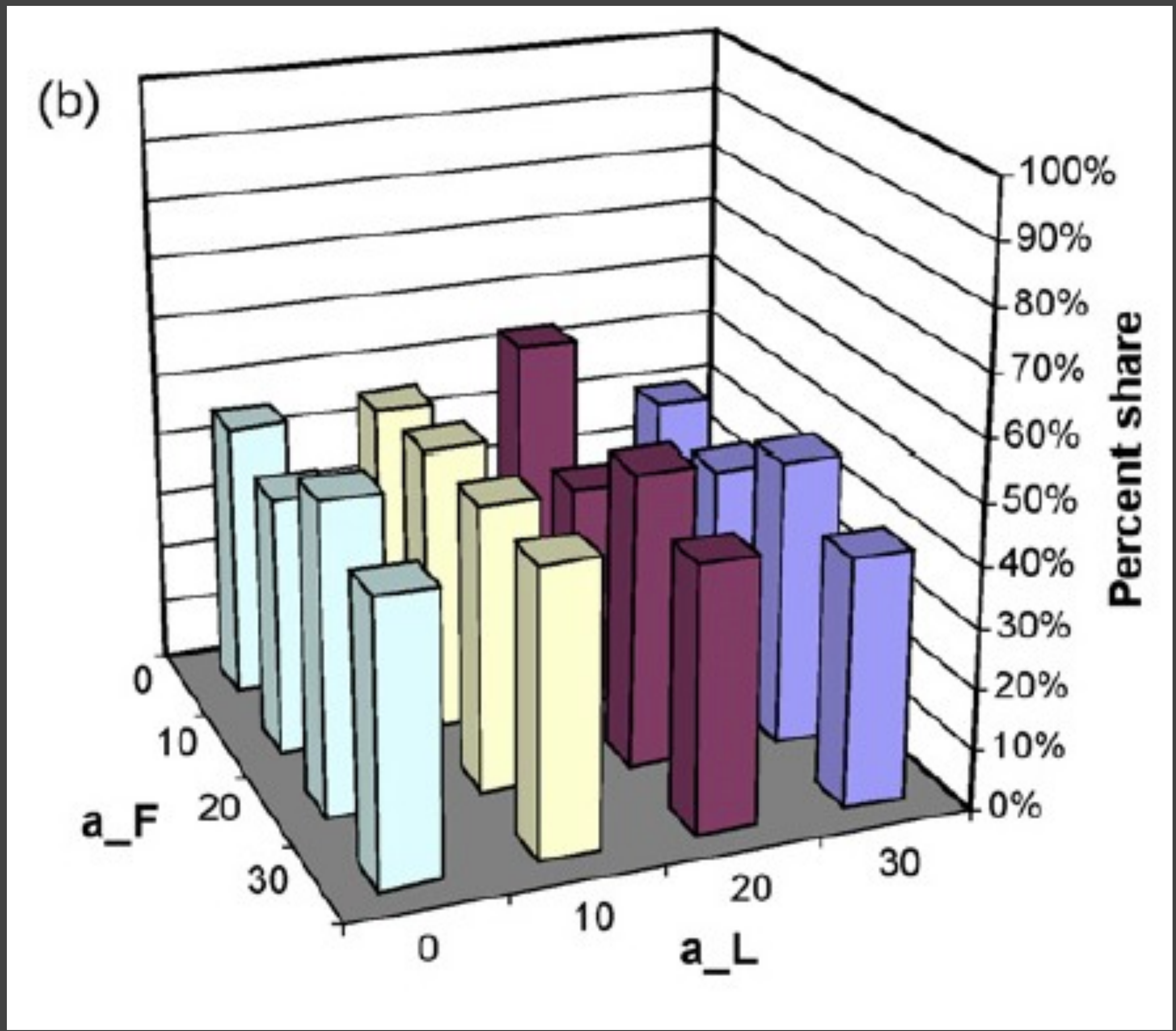
Knowledge sharing under inequity aversion

1. If followers are even slightly inequity averse they will always conceal if the leader has concealed. If the leader shares the follower will also share, if he or she is sufficiently inequity averse. The degree of inequity aversion needed to induce a follower to share increases in the follower's exclusivity payoff a_F.

2. The leader will always share if he expects the follower to share and conceal if the follower conceals.

Result 1

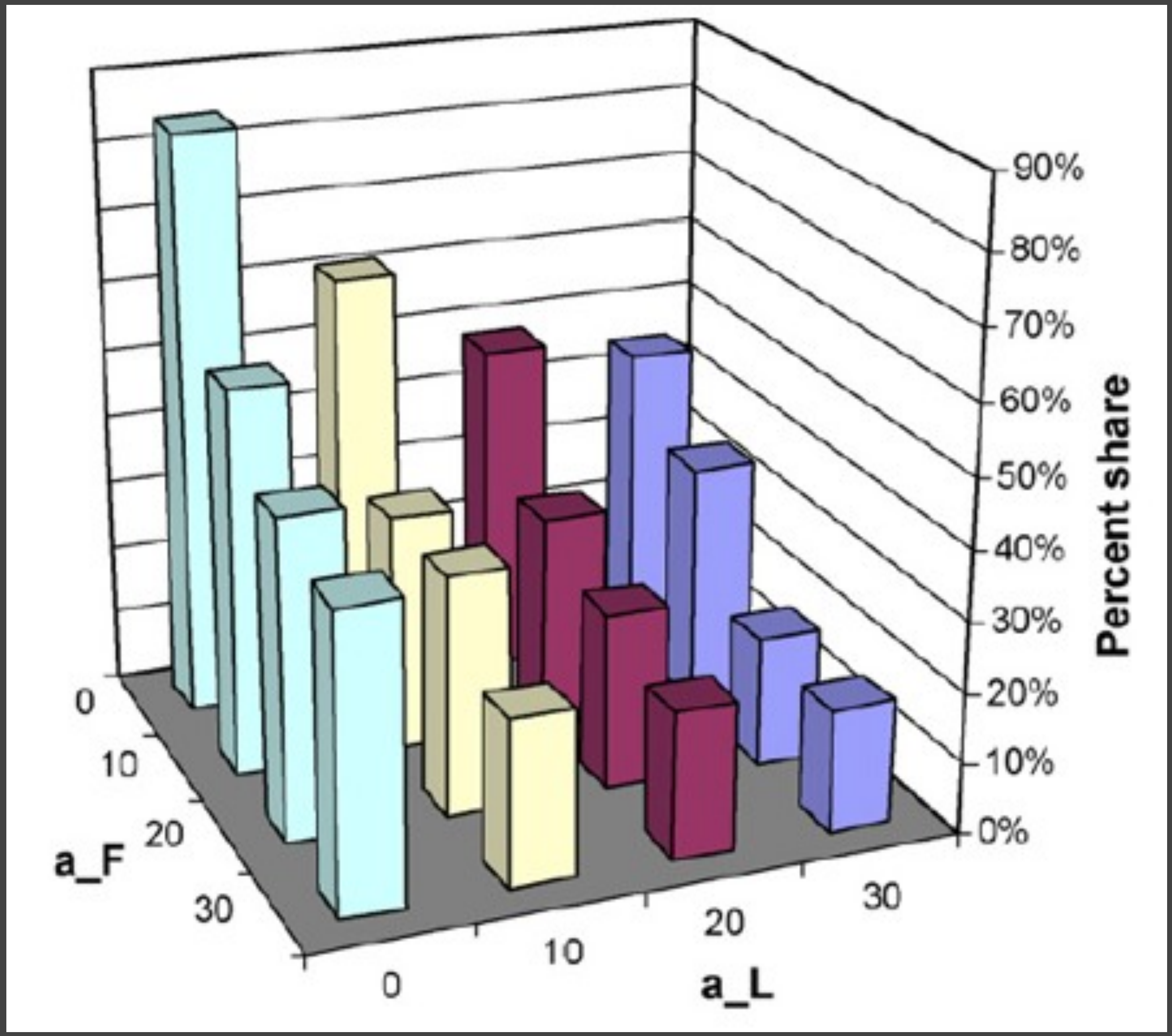




1. Contingent on the leader sharing, followers share in about 73% if $a_F = 0$. If $a_F > 0$ the probability that the follower shares drops.

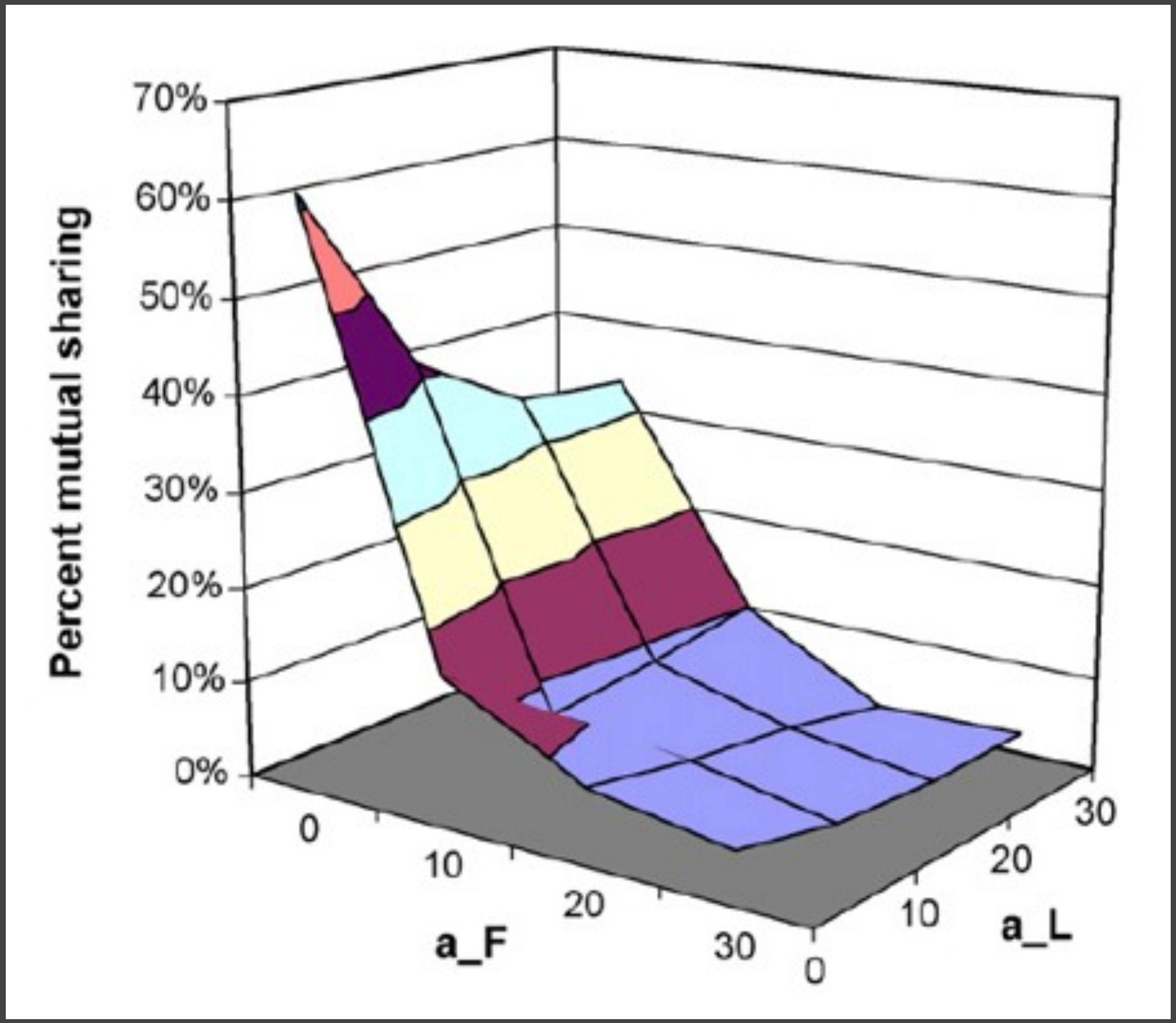
2. When the leader conceals, the probability of followers sharing is on average 45.3% across all a_F x a_L combinations.

Result 2



The probability that leaders share is affected negatively by both their own and their followers' exclusivity payoffs.

Result 3



Knowledge sharing is substantially more fragile in a_F than in a_L.