Fairness and Reciprocity

Michele Albach
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Questions to Answer

- What does it mean to act fairly?
- When do people act fairly?
    - What games exhibit fairness?
- Why do people act fairly?
    - What factors affect fairness?
- How can fairness be modelled?
    - Which models best support observed evidence?
- Future work?
    - What still needs to be done?

Outline

- Motivation
  - Games demonstrating fairness
- Modelling Fairness
  - Intentions-based models
  - Outcome-based models
  - Combining Intentions and Outcomes
- Comparing Models
- Recent Work
- Future Work

Motivation

Games demonstrating fairness

Fun Game: The Ultimatum Game (UG)

Güth *et al.*, 1982

There are two roles: the proposer and the responder

- The proposer has been given some amount (say $10) and must make an offer to split the amount with the responder
- The responder may either accept or reject the offer
- If the offer is accepted, the money is split according to the offer
- If the offer is rejected, both players receive nothing
- Play this game at least once as each role

Equilibrium in the Ultimatum Game

Güth *et al.*, 1982

- Since something is better than nothing, the responder should accept any positive offer
- Knowing this, the proposer should offer the smallest amount possible
- Experimental data does not support this equilibrium, why?
    - Because proposers want to be fair?
    - Because proposers are afraid that their offer will be rejected?
    - Other reasons?

UG Results

Güth *et al.*, 1982

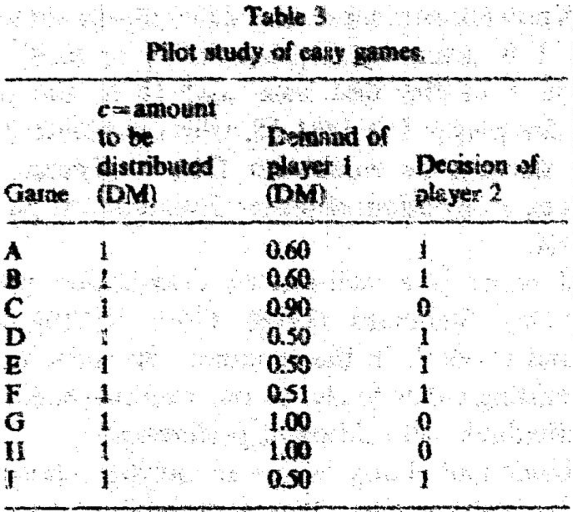
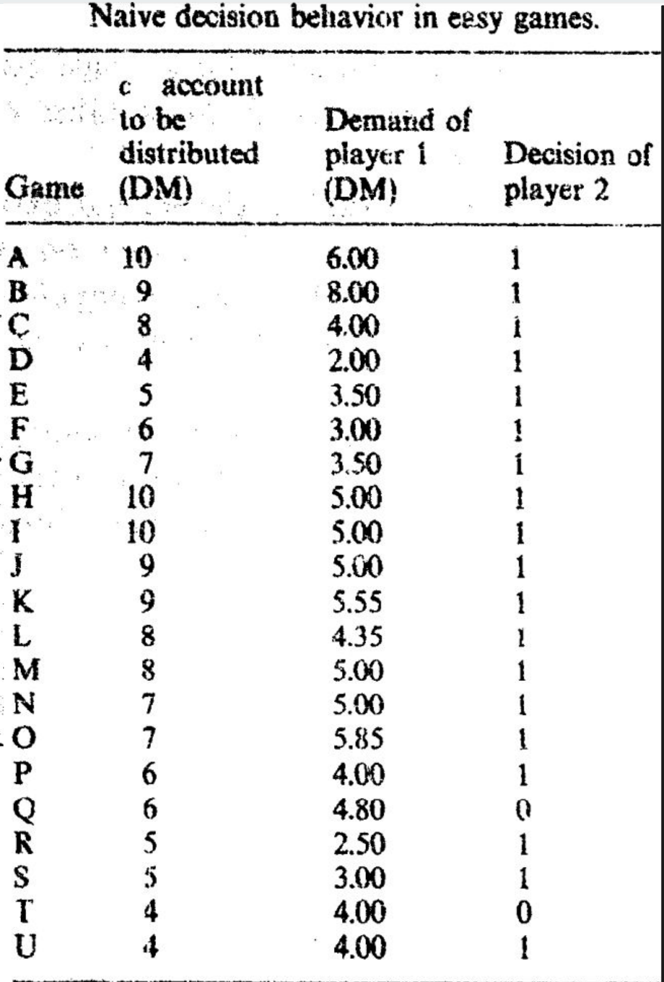


Table 3

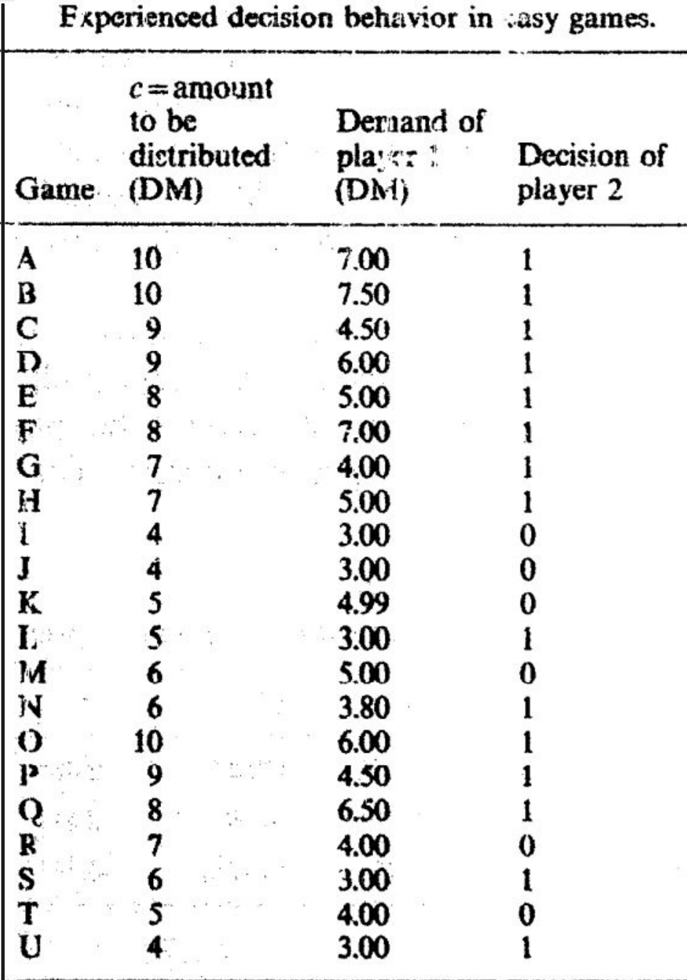
Pilot study of easy games.

Game	c = amount to be distributed (DM)	Demand of player 1 (DM)	Decision of player 2
A	1	0.60	1
B	1	0.60	1
C	1	0.90	0
D	1	0.50	1
E	1	0.50	1
F	1	0.51	1
G	1	1.00	0
H	1	1.00	0
I	1	0.50	1



Naive decision behavior in easy games.

Game	c account to be distributed (DM)	Demand of player 1 (DM)	Decision of player 2
A	10	6.00	1
B	9	8.00	1
C	8	4.00	1
D	4	2.00	1
E	5	3.50	1
F	6	3.00	1
G	7	3.50	1
H	10	5.00	1
I	10	5.00	1
J	9	5.00	1
K	9	5.55	1
L	8	4.35	1
M	8	5.00	1
N	7	5.00	1
O	7	5.85	1
P	6	4.00	1
Q	6	4.80	0
R	5	2.50	1
S	5	3.00	1
T	4	4.00	0
U	4	4.00	1



Experienced decision behavior in easy games.

Game	c = amount to be dictributed (DM)	Demand of player 1 (DM)	Decision of player 2
A	10	7.00	1
B	10	7.50	1
C	9	4.50	1
D	9	6.00	1
E	8	5.00	1
F	8	7.00	1
G	7	4.00	1
H	7	5.00	1
I	4	3.00	0
J	4	3.00	0
K	5	4.99	0
L	5	3.00	1
M	6	5.00	0
N	6	3.80	1
O	10	6.00	1
P	9	4.50	1
Q	8	6.50	1
R	7	4.00	0
S	6	3.00	1
T	5	4.00	0
U	4	3.00	1

Other games that exhibit fairness: Altruism

- Dictator Game (DG) (Forsythe *et al.*, 1994)
  - Same as the ultimatum game but the responder must accept
  - Proposers offer less, some offer nothing (36%), but some still offer positive amounts
    - So results from the ultimatum game are not only due to fairness
- Gift Exchange Game (GEG) (Fehr *et al.*, 1993)
  - An employer offers a 'wage' *w* to a worker
  - If accepted, the worker chooses an 'effort level' *e* to give in return
  - Employers cannot enforce effort levels
  - Employers receive a payoff of *ve-w* for some value of effort *v*
  - Workers receive a payoff *w-c(e)* for some effort cost function *c*
  - "At the individual level reciprocal behaviour is the dominant behavioural pattern" (Fehr *et al.*, 1993)
    - Workers give increasingly positive values for *e* with increasing values for *w*
  - Would this result change in single-shot *vs.* repeated games?
    - Gaechter and Falk, 2001
    - Effort levels increase with repeated interaction, but are also observed in single-shot games

Other games that exhibit fairness: Spitefulness

- Public Good Games (PGG) (Fehr and Gächter, 2000)
  - N subjects are each given an amount y and simultaneously choose to invest g_i ($0 \leq g_i \leq y$) into a public goods project
  - No-punishment treatment:
    - The payoff of each subject is $y - g_i + a\sum g_j$ where a is some per capita return on the project and g_j is the amounts contributed by the other subjects
    - a is set ($0 < a < 1 < na$) so that the best outcome is if all subjects contribute 100% of y
  - Punishment treatment:
    - In a second stage of the game, after all players see everyone else's contributions, players can choose to punish each other at a cost to their own payoff
  - Punishing others is a dominated strategy, so results should be the same in both treatments
  - Results:
    - Punishment occurs
    - Investments converge to zero over repeated interactions in the no-punishment treatment
    - Investments are on average 58% of y in the punishment treatment (and do not change over time)

Other games that exhibit fairness: Heterogeneity

- Trust Games (Berg *et al.*, 1995)
    - A trustor has some amount *y* and can choose to send *x* ($0 \le x \le y$) to the trustee, who actually receives *3x*
    - Then, the trustee can choose to send some amount *z* ($0 \le z \le 3x$) back to the trustor
    - Results:
        - Trustors sent varying amounts
        - Out of 28 trustees who were sent more than *x* = $1:
            - Some trustees sent back nothing or $1 (12)
            - Some trustees sent back more than what was sent to them (11)
        - So not all individuals act fairly, but some do

How to model fairness?

- There are two main categories for models of fairness (Fehr and Schmidt, 2003):
  - Intentions-based models
    - Players judge how kind their opponents are being by perceiving their intentions
  - Outcome-based models (social preference)
    - Players care about the outcomes that their opponents receive as well as their own outcome

Intentions-Based Models

Rabin Fairness (1993)

Rabin attempted to define the emotional responses behind fairness in 3 points:

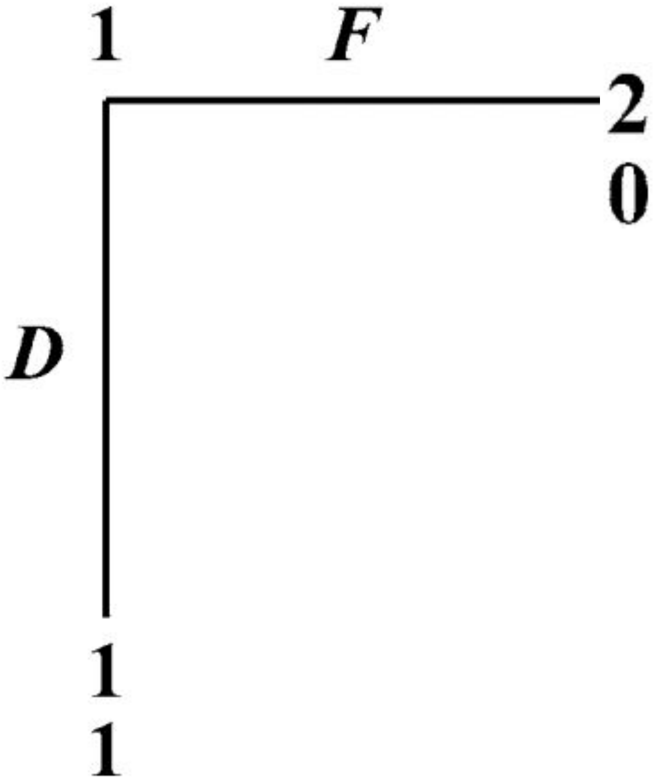
“

- People are willing to sacrifice their own material well-being to help those who are being kind
- People are willing to sacrifice their own material well-being to punish those who are being unkind
- Both [previous motivations] have a greater effect on behaviour as the material cost of sacrificing becomes smaller

“

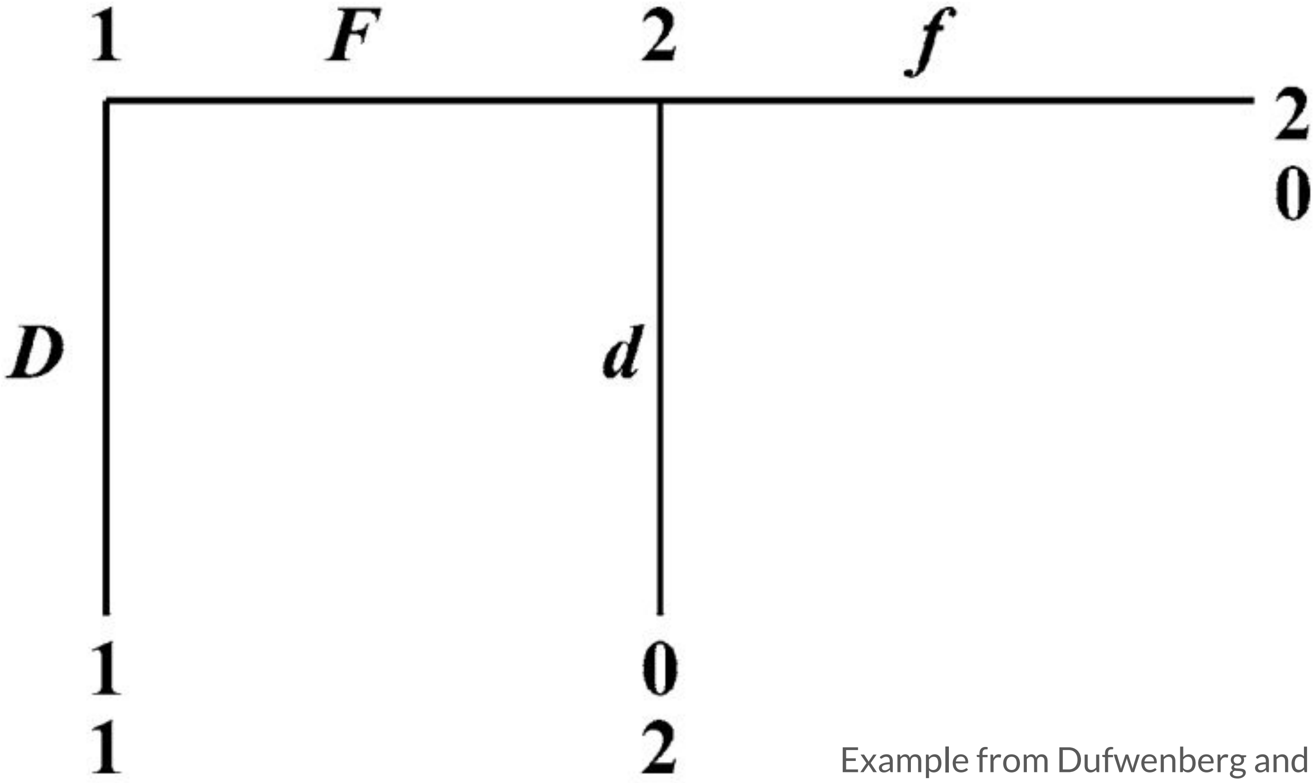
The first two points are the definition for reciprocity

What does it mean to be kind?



Example from Dufwenberg and Kirchsteiger, 2004

What does it mean to be kind?



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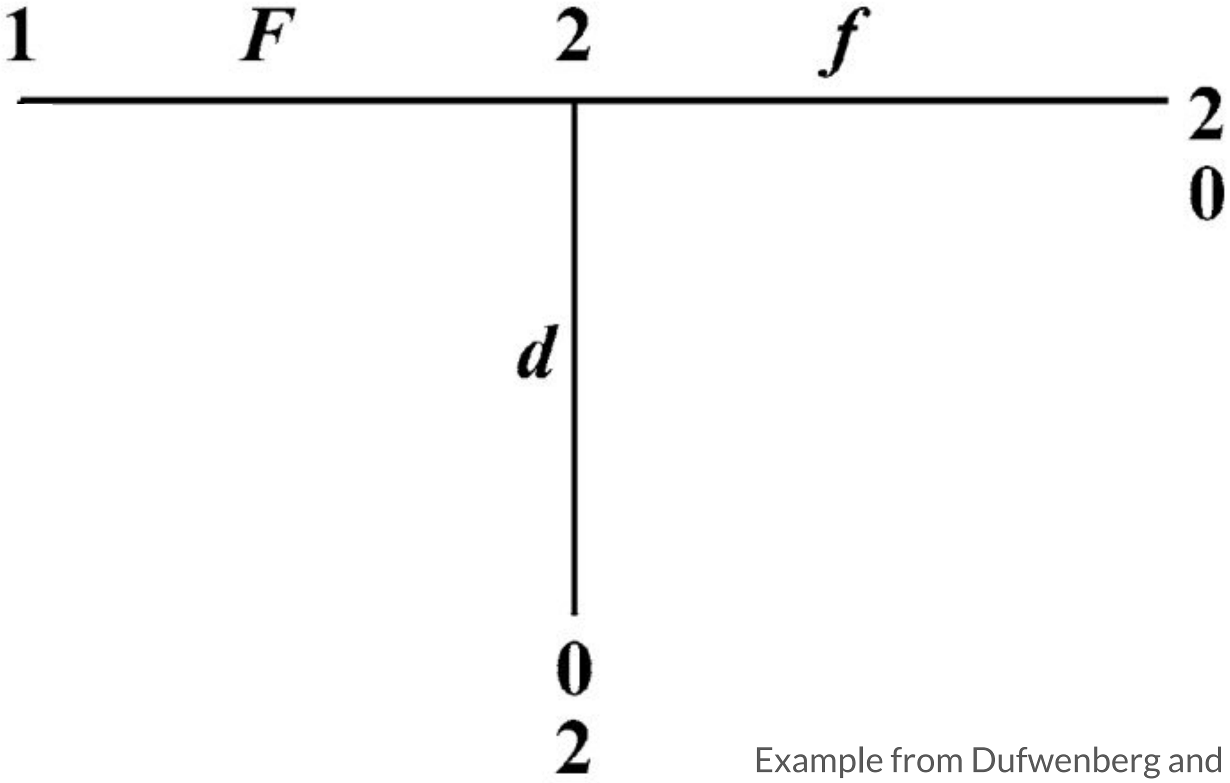


Example from Dufwenberg and Kirchsteiger, 2004

Rabin Fairness (1993)

- Only defined for 2-player normal form perfect information games (players *i* and *j*)
- Define:
  - a_i is player *i*'s action, b_i is the action that *j* believes *i* will play, and c_i is the action that *i* believes that *j* believes *i* will play
  - π is the material payoff function
  - $\pi_j^h(b_j)$ is player *j*'s highest possible payoff if they play b_i
  - $\pi_j^\ell(b_j)$ is player *j*'s lowest possible payoff out of non-Pareto-dominated points if they play b_j
  - $\pi_j^e(b_j) = [\pi_j^h(b_j) + \pi_j^\ell(b_j)]/2$ is the 'equitable payoff'
  - $\pi_j^{min}(b_j)$ is player *j*'s worst possible payoff if they play b_j
- Define a kindness function $f_i(a_i,b_j)$ measuring *i*'s kindness towards *j*:

$$f_i(a_i,b_j) \equiv \frac{\pi_j(b_j,a_i) - \pi_j^{\mathrm{e}}(b_j)}{\pi_j^{\mathrm{h}}(b_j) - \pi_j^{\mathrm{min}}(b_j)}.$$

$$\text{If } \pi_j^{\mathrm{h}}(b_j) - \pi_j^{\mathrm{min}}(b_j) = 0, \text{ then } f_i(a_i,b_j) = 0.$$

- Player *i*'s belief about how kind *j* is being to them is defined similarly as $f_j(b_j,c_i)$

Rabin Fairness (1993)

- Expands on Geanakoplos *et al.*’s (1989) model for ‘psychological games’
  - Allows utilities to depend on player’s beliefs as well as actions
- Adds the kindness function to utility:

$$U_i(a_i,b_j,c_i) \equiv \pi_i(a_i,b_j) + \tilde{f}_j(b_j,c_i)\cdot\left[1+f_i(a_i,b_j)\right]$$

- Next, uses Geanakoplos *et al.*’s concept of ‘psychological Nash equilibrium’ to define ‘fairness equilibrium’
  - (a_1,a_2) is a fairness equilibrium if for i = 1,2, a_i is best responding and $a_i = b_i = c_i$

Critiques of Rabin Fairness

- Limited to 2-player normal form games
- Assumes players are homogeneously fair
- Creates multiple and sometimes unrealistic fairness equilibria
  - Always at least one kind equilibrium and at least one unkind equilibrium
  - In UG, creates equilibria in which the responder receives more than 50% (Fehr and Schmidt, 2003)
- Is fairness actually more prominent with smaller material cost?
  - If so, could assume that fairness is less prominent with higher material cost
  - Research has found conflicting results:
    - Cameron, 1999 found that offers were still rejected at higher stakes
    - Anderson *et al.*, 2011 found that rejections decreased at higher stakes
  - Note: These studies were done in developing countries (Indonesia and Northeast India) to allow for higher payoffs
    - This brings into play questionable ethics and various factors that could affect results

Extending to Sequential N-player games

Dufwenberg and Kirchsteiger, 2004

- Allow beliefs to change, dependent on the history of the game
- Extend the kindness function to depend on history
  - Note that they remove Rabin's normalization for simplicity

$$\kappa_{ij}\left(a_i(h), \left(b_{ij}(h)\right)_{j\neq i}\right) = \pi_j\left(a_i(h), \left(b_{ij}(h)\right)_{j\neq i}\right) - \pi_j^{e_i}\left(\left(b_{ij}(h)\right)_{j\neq i}\right)$$

- Redefine utility to include reciprocity with all other players
  - $Y_{ij} > 0$ represents how much *i* cares about being reciprocal to *j*

$$\begin{aligned} &U_i\left(a_i(h), \left(b_{ij}(h), \left(c_{ijk}(h)\right)_{k\neq j}\right)_{j\neq i}\right) \\ &\quad = \pi_i\left(a_i(h), \left(b_{ij}(h)\right)_{j\neq i}\right) \\ &\qquad + \sum_{j\in N\setminus\{i\}} \left(Y_{ij} \cdot \kappa_{ij}\left(a_i(h), \left(b_{ij}(h)\right)_{j\neq i}\right) \cdot \lambda_{iji}\left(b_{ij}(h), \left(c_{ijk}(h)\right)_{k\neq j}\right)\right) \end{aligned}$$

- Define a sequential reciprocity equilibrium (SRE) similarly to fairness equilibrium
- Sebald, 2010 extends Dufwenberg and Kirchsteiger's model to allow for chance (nature player)

Outcome-Based Models

Altruistic or Spiteful?

Levine, 1998

- Gives all players a coefficient of altruism: $-1 < a_i < 1$
    - If $a_i > 0$ player *i* is altruistic, if $a_i < 0$ player *i* is spiteful, if $a_i = 0$ player *i* is selfish
- Update utility to incorporate other player's outcomes (u_j)

$$v_i = u_i + \sum_{j \neq i} \frac{a_i + \lambda a_j}{1 + \lambda} u_j$$

- Assumes lambda is the same for everyone
    - Estimates using ultimatum game data from Roth *et al.* (1991), finds lambda = 0.45
- Levine shows that his model can explain results from other games
    - Auction game, centipede, public good game
- Problems with this model
    - Cannot explain altruistic results from dictator games
    - Assumes individuals are consistently either altruistic or spiteful

Inequity Aversion

Fehr and Schmidt, 1999

- Motivated by Loewenstein *et al.*, 1989
  - Asked subjects to react to described situations in which they and another person would receive some payoffs
  - Found that individuals preferred equality over both disadvantageous and advantageous inequality
- Fehr and Schmidt allow for players who are averse to both disadvantageous and advantageous inequality
  - Assumes that they are more averse to disadvantageous inequality
- Define:
  - x_i as player *i*'s material payoff
  - β_i ($0 \leq \beta_i < 1$) represents *i*'s aversion to advantageous inequality
  - α_i ($\beta_i \leq \alpha_i$) represents *i*'s aversion to disadvantageous inequality
- Update utility to include aversion to inequality

$$U_i(x) = x_i - \alpha_i \frac{1}{n-1} \sum_{j \neq i} \max\{x_j - x_i, 0\} - \beta_i \frac{1}{n-1} \sum_{j \neq i} \max\{x_i - x_j, 0\}$$

- Fehr and Schmidt show that their model can explain game results
  - UG, market games, PGG
  - However, their model predicts too extreme results in some games like DG and GEG

ERC: Equity, Reciprocity, and Competition

Bolton and Ockenfels, 2000

- Uses a ‘social reference point’: the average of all player’s payoffs
- Define σ_i as player *i*’s relative share of the total payoff:

$$\sigma_i = \sigma_i(y_i, c, n) = \begin{cases} y_i/c & \text{if } c > 0 \\ 1/n & \text{if } c = 0 \end{cases} \qquad c = \sum_{j=1}^{n} y_j$$

- Extend utility to depend on σ_i
- Problem: using the average payoff *vs.* comparing to each opponent (Fehr and Fischbacher, 2004)
    - Performed ‘third-party’ dictator game
        - Player 1 is given 100 points and can choose to give some to player 2
        - Player 3 is given 50 points (⅓ of the total payoff)
        - After seeing player 1’s choice, player 3 can choose to punish them at a cost to their own total points
    - 26% (n = 46) of third-parties punished when player 1 offered player 2 less than 50 points
    - So players care about equity over all players, not just themselves

Intentions or Outcomes?

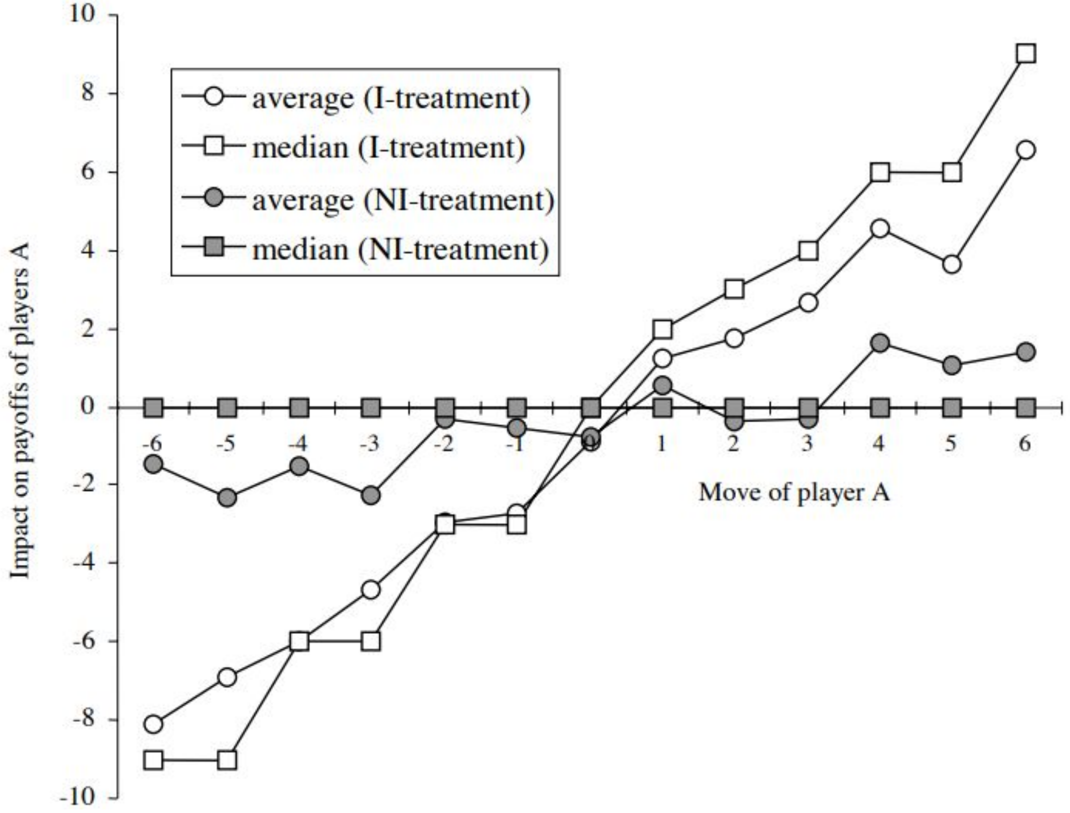
Intentions- *vs.* Outcome-Based Models

Falk, Fehr, and Fischbacher, 2008

- Moonlighting game (Abbink *et al.*, 2000)
    - Imagine an illegal moonlighter has taken a job from a client and been given funds to complete it
    - The moonlighter can choose to either complete the job or to take the funds and run
    - Next, the client can choose to either pay the moonlighter, do nothing, or attempt to punish the moonlighter at the cost of their own wellbeing
        - The activity is illegal so that any initial contract cannot be legally enforced
- Falk, Fehr, and Fischbacher's version of the game:
    - Each player is given 12 points
    - In the first stage, player A can choose to give or take up to 6 points to/from player 2
        - If they give *x* points (complete the job), player B receives 3*x* points
    - In the second stage, player B can choose to give or remove (punish) up to 18 points to/from player A
        - For every point removed, player B loses ⅓ of a point
    - Two treatments:
        - Intention treatment - as described above
        - No-intention treatment - player A's action decided by random device

Intentions- *vs.* Outcome-Based Models

Falk, Fehr, and Fischbacher, 2008



- Clearly, intentions matter
  - Most players neither rewarded or punished when there were no intentions
  - Models that ignore intentions cannot be entirely accurate
- Outcomes also matter
  - Some players still rewarded or punished despite the lack of intentions
  - Models that purely use intentions cannot be entirely accurate either
- Try incorporating both?

Combining Intentions and Outcomes

Falk and Fischbacher, 2006

- Define for 2 player game (They expand to N-player in their appendix):
    - π is the material payoff function
    - *n* is the current node
    - s_i is player *i*'s action, s_i' is the action that *i* believes *j* will play, and s_i'' is the action that *i* believes that *j* believes *i* will play
        - Note this is similar to a_i, b_j, c_i in Rabin fairness
    - Define an 'intention factor' δ (0 ≤ δ ≤ 1)
        - δ = 1 means that an outcome was produced intentionally by player *j*, δ < 1 means less or no intentions
        - This value depends on if player *j* had other options
    - Define an 'outcome term' Δ_i to be the player *i*'s expected difference between their payoff and their opponents payoff
        - Positive for advantageous, negative for disadvantageous

$$\Delta(n) := \pi_i(n, s_i'', s_i') - \pi_j(n, s_i'', s_i')$$

Combining Intentions and Outcomes

Falk and Fischbacher, 2006

- Define:
  - The ‘kindness term’ φ is the product of the intention factor and the outcome term
  - f is some end node
  - $v(n,f)$ is the node following n on the path to f
  - The ‘reciprocation term’ σ represents i’s kindness to j for an action in node n

$$\sigma(n,f) := \pi_j(\nu(n,f), s_i'', s_i') - \pi_j(n, s_i'', s_i')$$

  - The ‘reciprocity parameter’ ρ_i represents i’s tendency to play reciprocally
- Update utility

$$U_i(f) = \pi_i(f) + \rho_i \sum_{\substack{n \to f \\ n \in N_i}} \varphi(n)\sigma(n,f)$$

- Falk and Fischbacher show that their model can explain game results
  - UG, GEG, DG, PGG, Prisoner’s Dilemma

Recap of Models

- Intentions-Based
    - Rabin, 1993
        - Presented first kindness function using beliefs
        - Used Geanakoplos *et al.*’s ‘psychological game’ to allow utility to depend on beliefs and define ‘fairness equilibria’
        - Relatively simple
        - Only for 2-player normal form games
        - Creates multiple and sometimes unrealistic equilibria
    - Dufwenberg and Kirchsteiger, 2004
        - Extended Rabin fairness to N-player sequential games
        - Further extended by Sebald, 2010 to allow chance plays
- Outcome-Based
    - Levine, 1998
        - Assumed players are either altruistic or spiteful using ‘coefficient of altruism’
        - Cannot explain results from Dictator Games

Recap of Models

- Outcome-Based (Cont)
  - Fehr and Schmidt, 1999
    - Assumes that players are averse to both disadvantageous and advantageous inequity
    - Sums the differences between player’s payoffs
    - Uses individual parameters α_i and β_i to allow for heterogeneity in players
    - Ignores intentions
    - Relatively simple
  - Bolton and Ockenfels, 2000
    - Similar to Fehr and Schmidt, but uses a ‘relative share’ comparison to the average payoffs
    - Assumes that players only care about their relative payoff, not the distribution across all other players
    - Fehr and Fischbacher, 2004 show that this assumption is incorrect using the ‘third-party’ dictator game
    - Also ignores intentions
- Combining Intentions and Outcomes
  - Falk and Fischbacher, 2000
    - Works for N-player extensive-form games
    - Use both an ‘outcome term’ describing the difference in outcomes and an ‘intention factor’ determining the intentions of the other player
    - Very complex

More Recent Work

- Motives (Orhun, 2015)
  - Examines reactions to kind actions that could be strategically motivated
  - Finds that players are less likely to reward kind actions in the case when that action could have been chosen strategically
  - Highlights the importance of motives as well as intentions
- Kindness through blame (Çelen *et al.*, 2017)
  - Formalizes the idea of *blame* as if an opponent's action is better or worse than what the player would do in their shoes
  - Redefines the kindness function using blame
- Hidden intentions (Friehe and Utikal, 2018)
  - Examines reactions to when players attempt to hide their intentions
  - After choosing either a kind or unkind action, allows players the option of paying to decrease the chance that their opponent will know their choice
  - Finds that hiding intentions is considered to be unkind, but not as much as overt unkind actions

Future Work

- Better comparison of existing models
  - Difficult to find extensive list of current models
  - Unsure if work exists comparing them all
- Continue to combine models
  - Varying models are all good for different reasons/in different scenarios
- Find additional factors that affect fairness
  - Factors like motives and hidden intentions are interesting, perhaps more
  - For example: Mood? Relationship with opponent (stranger or friend)? Experience?
    - I have not extensively searched for existing work on these topics

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