Social contagion, inequality and mobility

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Motivation

- Interdependence shapes individuals and social structures
- The economic literature focuses on:
  - diffusion of practices, beliefs, values... (Durlauf and Ioannides 2010)
  - influence on inequalities via individual behavior and choice: (Saez 2021, Jackson 2024)
    - unequal opportunities due to social connections (e.g., through job referrals)
    - unequal access to information
    - peer influence (norms and culture)
- Epidemiological models have inspired few economic analyses of diffusion and influence (Young 2009 on innovation, Jackson and Yariv 2007 on diffusion, Shiller 2019 on narratives)

A macro-social perspective

- "Although social interactions models take sociological ideas seriously, they fully preserve the purposeful, choice-based formulation of individual decision making that is the hallmark of modern economics. These models simply expand the domain of factors that determine individual decisions." (Durlauf and Ioannides 2010)
- Here the black box of individual decisions and strategies is for the most part taken as given, and we study the social statistics (inequality, mobility) induced by basic contagion parameters
- Contagion models are useful to describe the impact of interactions on how individuals thrive and how this shapes society

Our contribution

- Propose a variant of the SIR epidemiological model, involving probabilities of social mobility induced by one-on-one encounters
- Propose a taxonomy of social interaction types based on the probability parameters
- Examine the properties of different interaction types in terms of social welfare, inequalities, mobility
- Introduce rational efforts to "meet the right people" and "do one's best" as variants of the model

This presentation

- Although simple, the model does not lend itself easily to analytical results
- Only simulation results will be presented
- Hopefully more will come at a later stage

The model

- Discrete time $t = 0, 1, ...$
- 3 unequal levels of flourishing (H, M, L)

$$H_t + M_t + L_t = 1$$

- Random one-on-one meetings between people (fixed number of contacts s)
- Each meeting has a probability of pushing an individual up or down
- The probability depends on the relative position of the parties

Probabilities and proportions

- Probabilities: α^+, α^- (when meeting a superior), β^+, β^- (meeting an equal), γ^+, γ^- (meeting an inferior)
- Probability of a move in a meeting:

$$\begin{aligned} p_{ht}^- &= \beta^- H_t + \gamma^- M_t + \gamma^- L_t \text{ for a } H \\ p_{mt}^\pm &= \alpha^\pm H_t + \beta^\pm M_t + \gamma^\pm L_t \text{ for an } M \\ p_l^+ &= \alpha^+ H_t + \alpha^+ M_t + \beta^+ L_t \text{ for an } L \end{aligned}$$

Probabilities of transitions

- Probability of a move after s meetings:

$$\begin{cases} h_t^- = \sum_{n=1}^{s} \left(1 - p_{ht}^-\right)^{n-1} p_{ht}^- = 1 - \left(1 - p_{ht}^-\right)^s \\ m_t^{\pm} = \sum_{n=1}^{s} \left(1 - p_{mt}^+ - p_{mt}^-\right)^{n-1} p_{mt}^{\pm} = \frac{p_{mt}^{\pm}}{p_{mt}^+ + p_{mt}^-} \left(1 - \left(1 - p_{mt}^+ - p_{mt}^-\right)^s\right) \\ l_t^+ = \sum_{n=1}^{s} \left(1 - p_{lt}^+\right)^{n-1} p_{lt}^+ = 1 - \left(1 - p_{lt}^+\right)^s \end{cases}$$

Dynamics

- The proportions H, M, L change accordingly:

$$\begin{cases} H_t = & H_{t-1}\left(1 - h^-_{t-1}\right) + M_{t-1} m^+_{t-1} \\ M_t = & H_{t-1} h^-_{t-1} + M_{t-1}\left(1 - m^+_{t-1} - m^-_{t-1}\right) + L_{t-1} l^+_{t-1} \\ L_t = & M_{t-1} m^-_{t-1} + L_{t-1}\left(1 - l^+_{t-1}\right) \end{cases}$$

A remark about SIR models

- The formula for m_t^- simplifies into

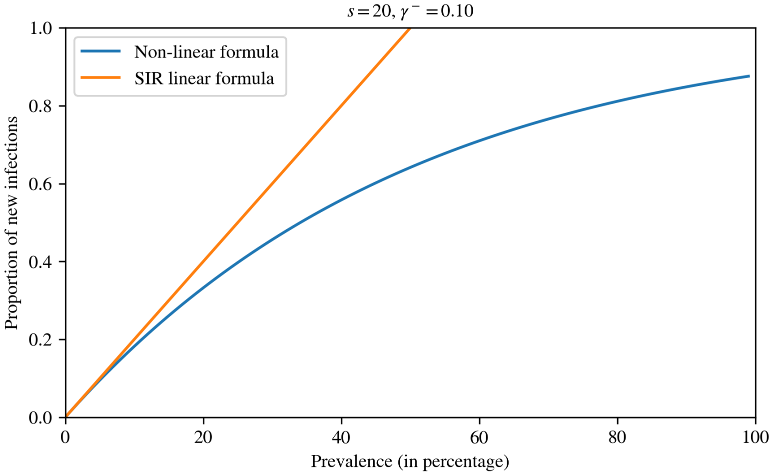
$$m_t^- = \sum_{n=1}^{s} \left(1 - p_{mt}^-\right)^{n-1} p_{mt}^- = 1 - \left(1 - p_{mt}^-\right)^s$$

for $p_{mt}^- = L_t \gamma^-$.

- Discrete-time SIR models (Gümüs 2022, Li and Eskandari 2023, Allen 1994, Kermack and McKendrick 1991) assume instead that $m_t^- = sL_t\gamma^-$. This is valid only for continuous time:

$$\lim_{\triangle t \to 0} \frac{1 - \left(1 - L_t\gamma^-\right)^{s\triangle t}}{\triangle t} = sL_t\gamma^-$$

A remark (cont'd)



Existence of a steady state

- The sequence (H_t, M_t, L_t) is defined by $L_t = 1 - H_t - M_t$ and a function
$$(H_t, M_t) = f\left(H_{t-1}, M_{t-1}\right),$$
where f is continuous on a convex compact set
- A fixed point of f (which exists by Brouwer's theorem) is a steady state
- If the matrix
$$T_t = \begin{bmatrix} 1 - h_t^- & m_t^+ & 0 \\ h_t^- & 1 - m_t^+ - m_t^- & l_t^+ \\ 0 & m_t^- & 1 - l_t^+ \end{bmatrix}$$
were constant, the steady state would be unique and stable (assuming non-zero diagonal cells). But more complex dynamics are possible.

The case $s = 1$

- The transition probabilities simplify into:

$$\begin{bmatrix} h^- \\ m^\pm \\ l^+ \end{bmatrix} = \begin{bmatrix} \beta^- & \gamma^- & \gamma^- \\ \alpha^\pm & \beta^\pm & \gamma^\pm \\ \alpha^+ & \alpha^+ & \beta^+ \end{bmatrix} \begin{bmatrix} H \\ M \\ L \end{bmatrix}$$

and $L = 1 - H - M$, so that the system

$$\begin{aligned} h^- H &= m^+ M \\ m^- M &= l^+ L \end{aligned}$$

can be rewritten as :

$$\left\{ \begin{array}{c} \left(\left(\beta^- - \gamma^-\right) H + \gamma^-\right) H = \left(\left(\alpha^+ - \gamma^+\right) H + \left(\beta^+ - \gamma^+\right) M + \gamma^+\right) M, \\ \left(\left(\alpha^- - \gamma^-\right) H + \left(\beta^- - \gamma^-\right) M + \gamma^-\right) M = \\ \left(\left(\alpha^+ - \beta^+\right) (H + M) + \beta^+\right) (1 - H - M) \end{array} \right.$$

- This system generates a quartic equation in M and a well defined function $H(M)$. A steady state in that case is defined by a real root M such that $H(M) \in [0, 1 - M]$.

A taxonomy

- Competition: $p(\downarrow) < p(\uparrow)$ only when meeting a lower class, and the higher the person encountered, the worse the prospects (9 linear orderings):

$$\alpha^+ < \beta^+ < \gamma^+;\ \alpha^- > \beta^- > \gamma^-;\ \alpha^+ < \alpha^-;\ \beta^+ < \beta^-;\ \gamma^+ > \gamma^-.$$

- Cooperation: $p(\downarrow) < p(\uparrow)$ in all meetings, and the higher the person encountered, the better the prospects (1 linear ordering):

$$\alpha^- < \beta^- < \gamma^- < \gamma^+ < \beta^+ < \alpha^+$$

- Attraction: $p(\downarrow) < p(\uparrow)$ only when meeting a higher class, the opposite when meeting a lower class (18 linear orderings):

$$\alpha^+ > \beta^+ > \gamma^+;\ \alpha^- < \beta^- < \gamma^-;\ \alpha^+ > \alpha^-;\ \gamma^- > \gamma^+.$$

- Homophily: $p(\downarrow) < p(\uparrow)$ only when meeting an equal (76 linear orderings):

$$\beta^+ > \alpha^+, \gamma^+, \beta^-;\ \beta^- < \alpha^-, \gamma^-$$

- Diversity: $p(\downarrow) < p(\uparrow)$ only when meeting another class (76 linear orderings):

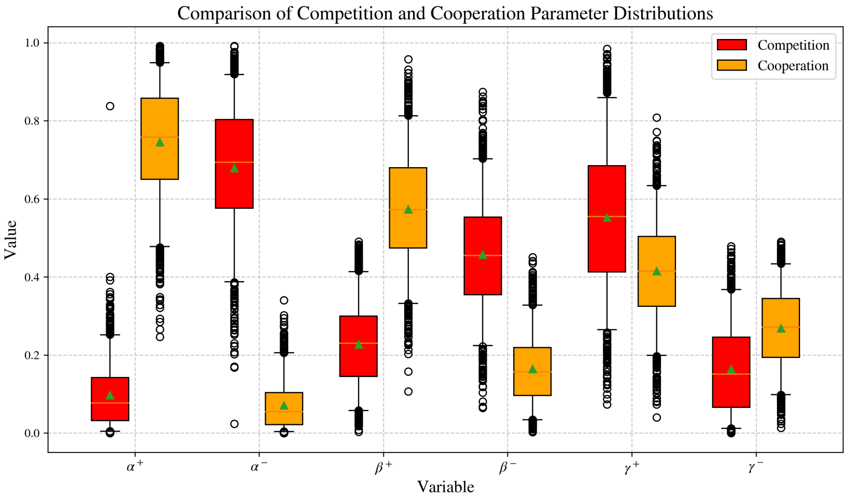
$$\beta^+ < \alpha^+, \gamma^+, \beta^-;\ \beta^- > \alpha^-, \gamma^-$$

Competition vs. cooperation

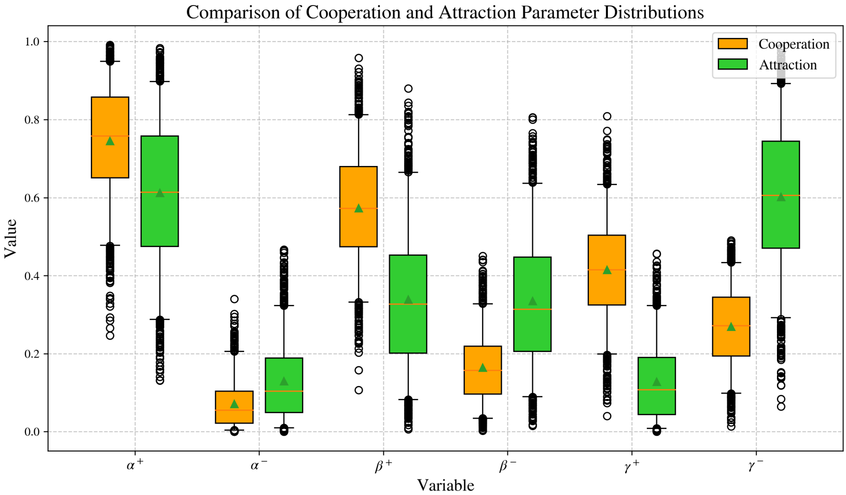
- The conventional view of competition is market trade, but it is actually a mix of competition (on the same side of the market) and cooperation (with the other side)
- The conventional view of cooperation is collective coordination and coalition formation, but it is again a mix: cooperation within coalitions, competition between coalitions
- Here competition is closer to tournaments in sports, or to competition for promotion in organizations
- Here cooperation is mutual support with unequal capacities for help

Parameter distributions

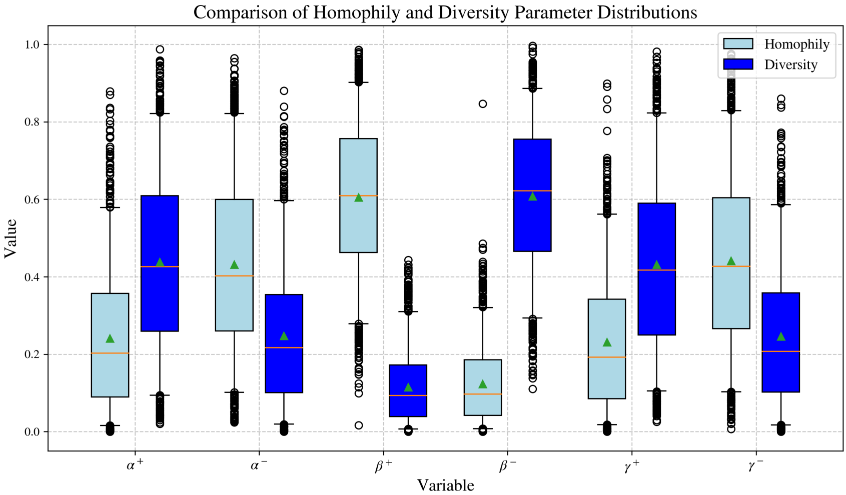
Based on a 1000-size random sample of parameters $\alpha^+, \alpha^-, \beta^+, \beta^-, \gamma^+, \gamma^-$



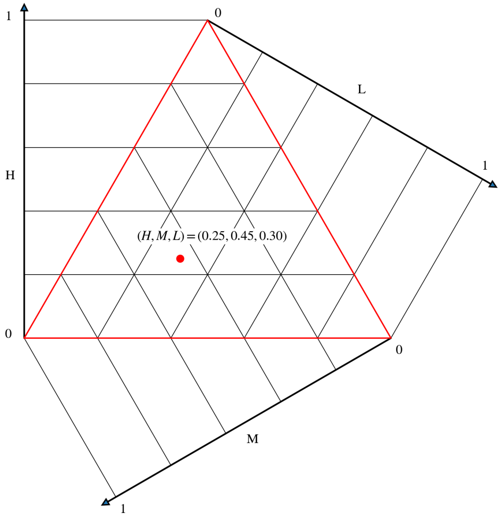
Parameter distributions



Parameter distributions

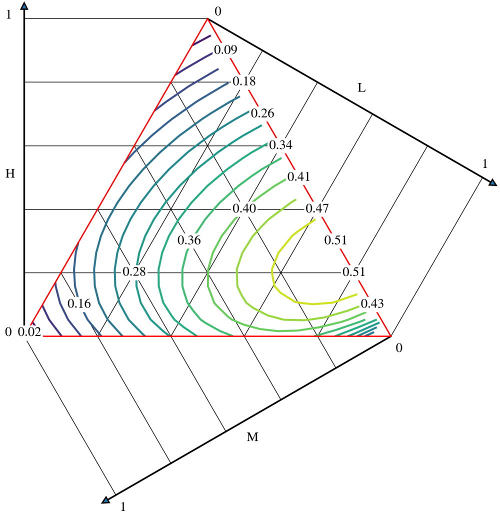


Representing social structure



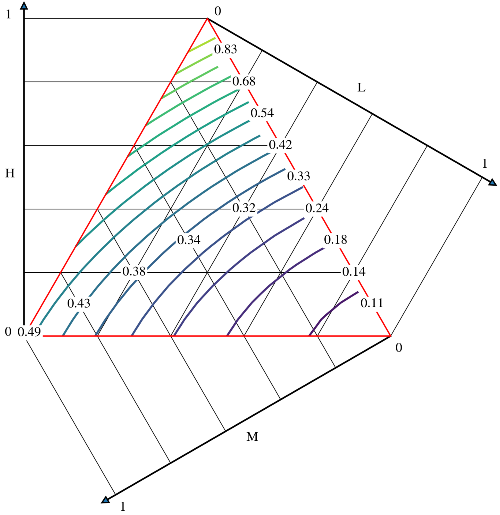
Gini inequality

Assuming $R = (1, 0.5, 0.1)$



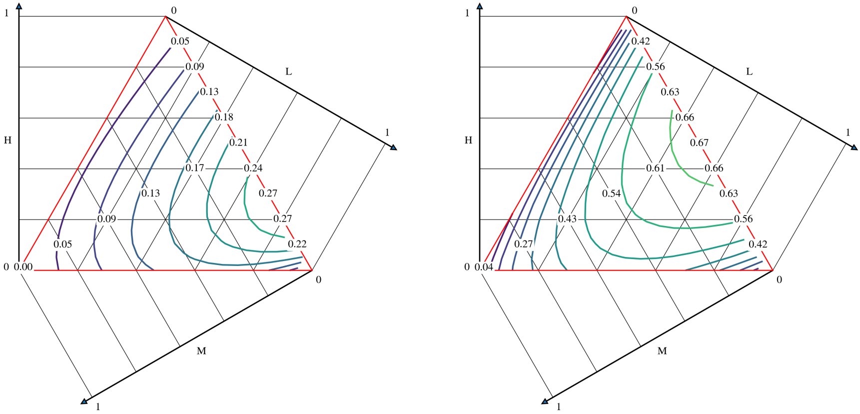
Gini social welfare

Social welfare = Average individual welfare × (1 − Inequality index)



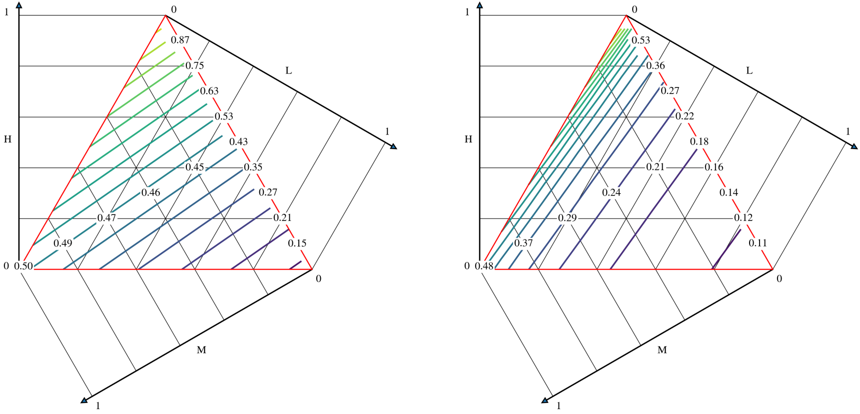
Atkinson inequality for 0.5 and 2

$$I = 1 - \frac{\left(HR_h^{1-\eta} + MR_m^{1-\eta} + LR_l^{1-\eta}\right)^{\frac{1}{1-\eta}}}{HR_h + MR_m + LR_l}$$



Atkinson social welfare for 0.5 and 2

$$W = \left(HR_h^{1-\eta} + MR_m^{1-\eta} + LR_l^{1-\eta} \right)^{\frac{1}{1-\eta}}$$



Mobility

- Based on the transition matrix at the steady state:

$$M_{\text{Determinant}} = 1 - \left|det\left(T\right)\right|^{1/2}.$$

- Based on leaps (transition matrix + welfare gap):

$$M_{\text{Difference}} = \left(Hh^{-} + Mm^{+}\right)\left(R_h - R_m\right) + \left(Mm^{-} + Ll^{+}\right)\left(R_m - R_l\right).$$

- Based on opportunities (short term):

$$\begin{aligned} M_{\text{Opportunities}} = &\\ &\Big(H\left(\left(1 - h^{-}\right)R_h + h^{-}R_m\right)^{1-\eta} \\ &+ M\left(m^{+}R_h + \left(1 - m^{+} - m^{-}\right)R_m + m^{-}R_l\right)^{1-\eta} \\ &+ L\left(l^{+}R_m + \left(1 - l^{+}\right)R_l\right)^{1-\eta}\Big)^{\frac{1}{1-\eta}} \end{aligned}$$

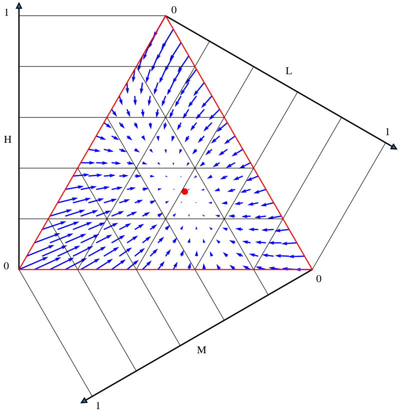
- Long-term opportunities:

$$M_{\text{LT-Opp}} = \left(H O_h^{1-\eta} + M O_m^{1-\eta} + L O_l^{1-\eta} \right)^{\frac{1}{1-\eta}},$$

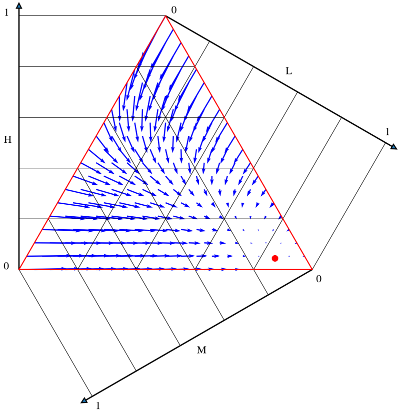
with

$$\begin{pmatrix} O_h \\ O_m \\ O_l \end{pmatrix} = \begin{pmatrix} R_h \\ R_m \\ R_l \end{pmatrix} + \beta T' \begin{pmatrix} O_h \\ O_m \\ O_l \end{pmatrix} = (I - \beta T')^{-1} \begin{pmatrix} R_h \\ R_m \\ R_l \end{pmatrix}$$

Examples: competition

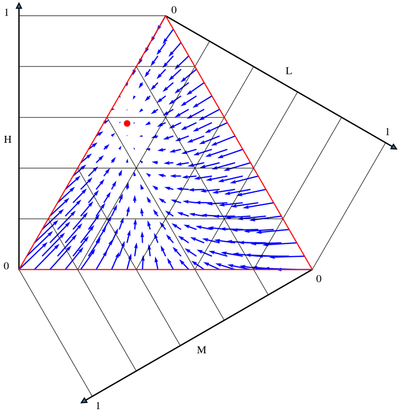


$\alpha^+ = 0.1, \alpha^- = 0.4, \beta^+ = 0.2, \beta^- = 0.3, \gamma^+ = 0.3, \gamma^- = 0.1, s = 2$

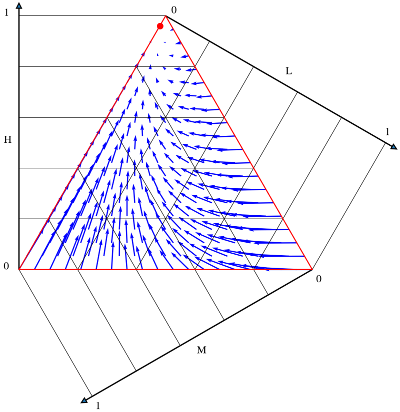


$\alpha^+ = 0.01, \alpha^- = 0.99, \beta^+ = 0.02, \beta^- = 0.98, \gamma^+ = 0.03, \gamma^- = 0.02, s = 2$

Examples: cooperation

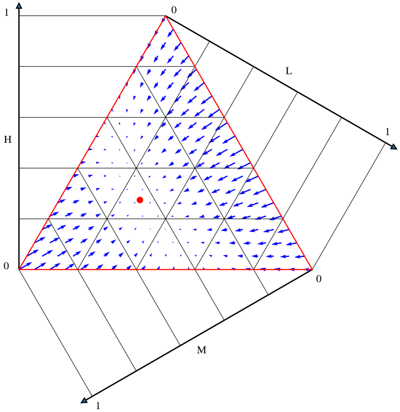


$\alpha^+ = 0.6, \alpha^- = 0.1, \beta^+ = 0.5, \beta^- = 0.2, \gamma^+ = 0.4, \gamma^- = 0.3, s = 2$

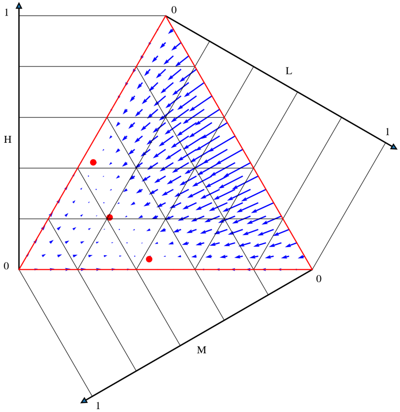


$\alpha^+ = 0.99, \alpha^- = 0.01, \beta^+ = 0.98, \beta^- = 0.02, \gamma^+ = 0.97, \gamma^- = 0.03, s = 2$

Examples: attraction

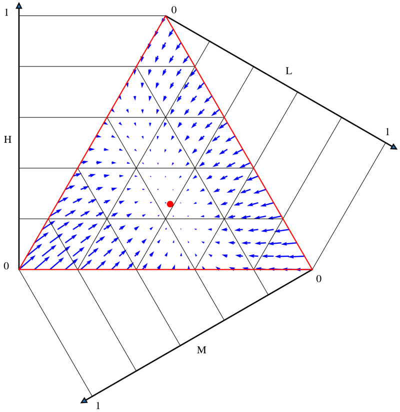


$\alpha^+ = 0.3, \alpha^- = 0.1, \beta^+ = 0.1, \beta^- = 0.1, \gamma^+ = 0.1, \gamma^- = 0.3, s = 2$

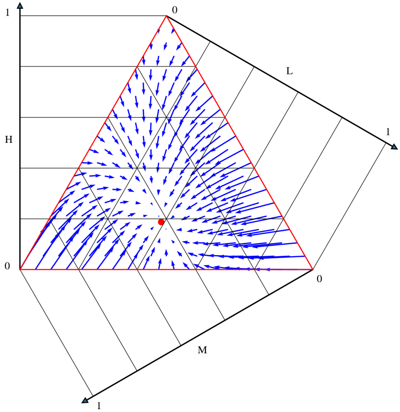


$\alpha^+ = 0.99, \alpha^- = 0.01, \beta^+ = 0.01, \beta^- = 0.01, \gamma^+ = 0.01, \gamma^- = 0.99, s = 2$

Examples: homophily

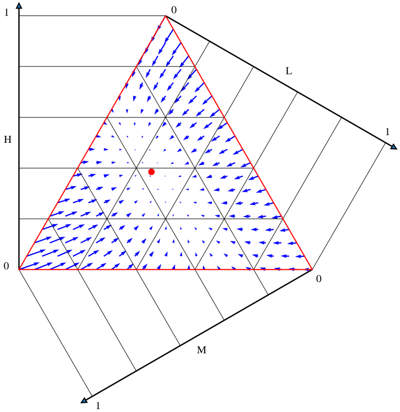


$\alpha^+ = 0.1, \alpha^- = 0.2, \beta^+ = 0.2, \beta^- = 0.1, \gamma^+ = 0.1, \gamma^- = 0.2, s = 2$

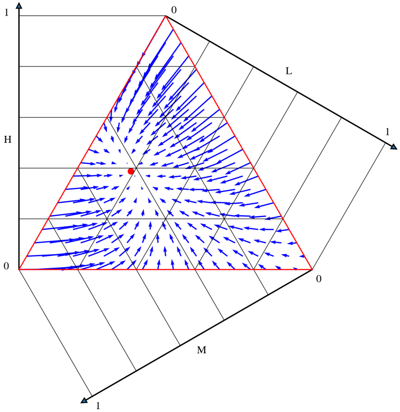


$\alpha^+ = 0.01, \alpha^- = 0.99, \beta^+ = 0.99, \beta^- = 0.01, \gamma^+ = 0.01, \gamma^- = 0.99, s = 2$

Examples: diversity

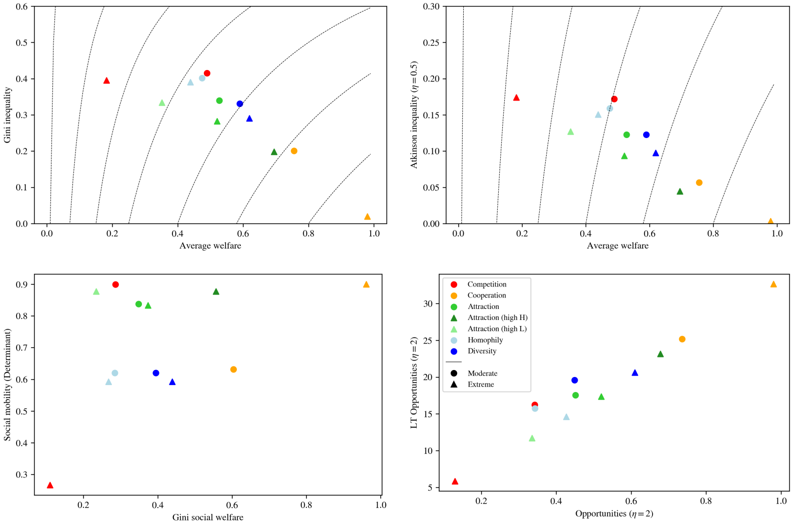


$\alpha^+ = 0.2, \alpha^- = 0.1, \beta^+ = 0.1, \beta^- = 0.2, \gamma^+ = 0.2, \gamma^- = 0.1, s = 2$



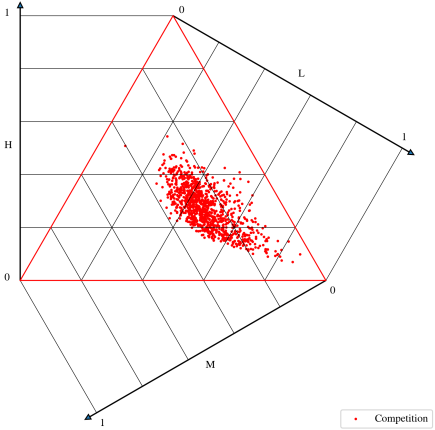
$\alpha^+ = 0.99, \alpha^- = 0.01, \beta^+ = 0.01, \beta^- = 0.99, \gamma^+ = 0.99, \gamma^- = 0.01, s = 2$

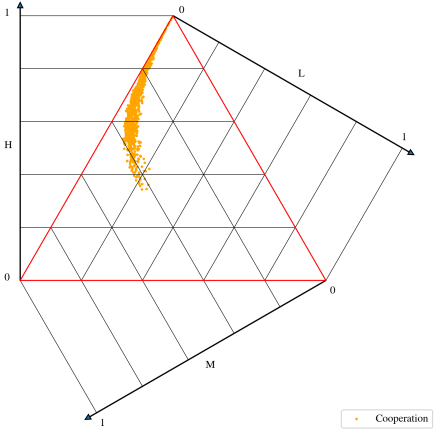
Comparison of the examples



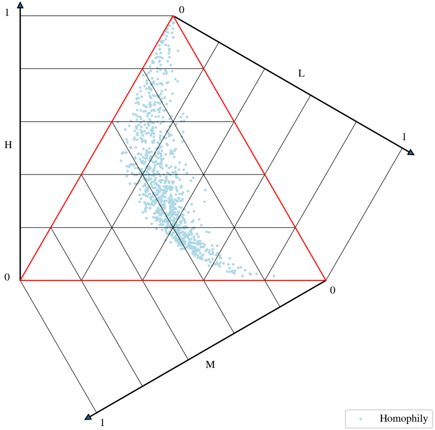
Comparison on large samples

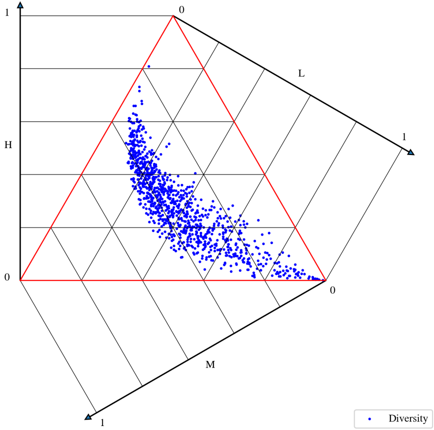
Competition, cooperation





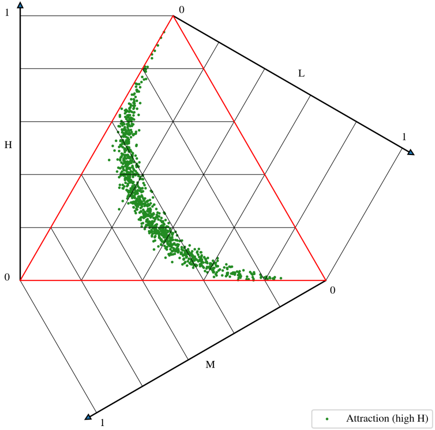
Comparison on large samples
Homophily, diversity

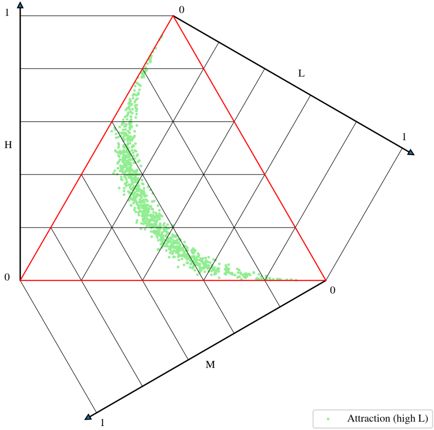




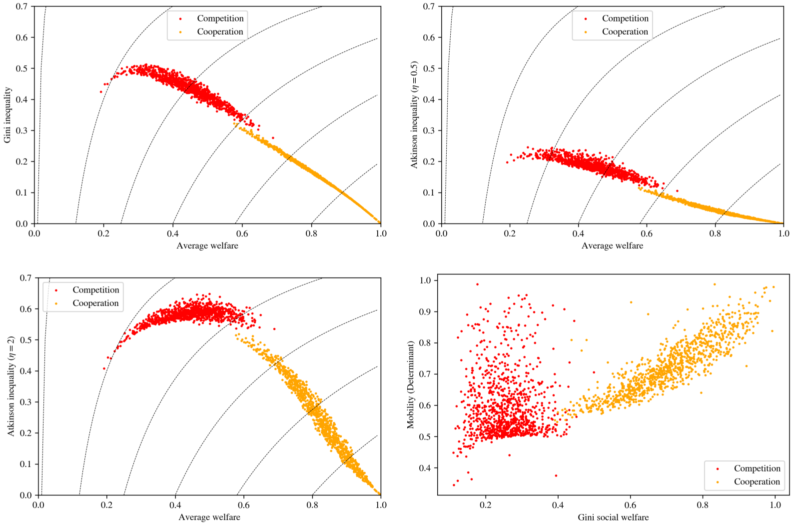
Comparison on large samples

Attraction (high H, high L)

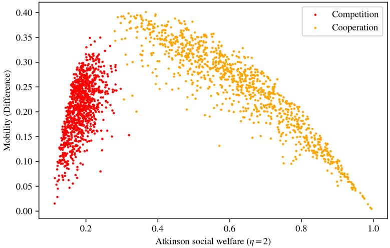


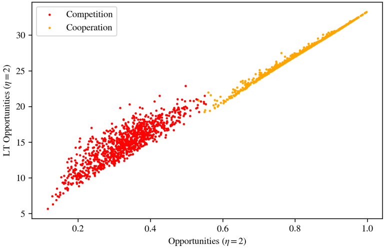


Comparison of social indicators

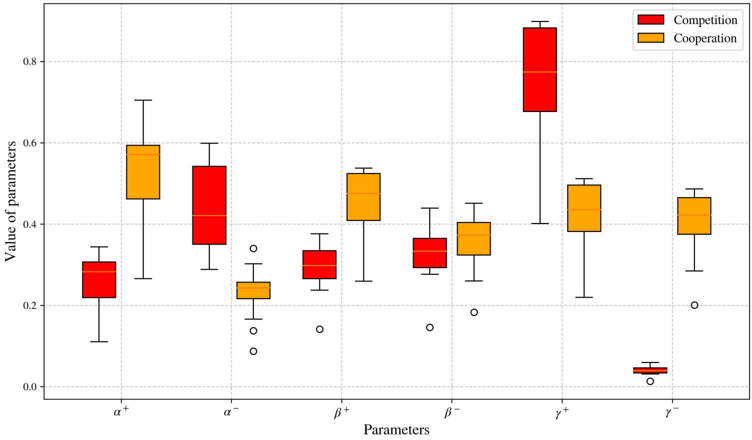


Comparison (cont'd)

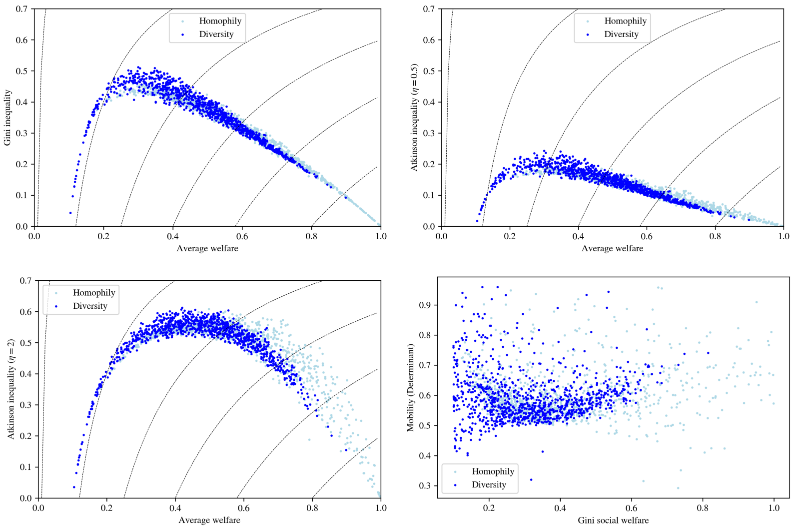




When competition dominates cooperation



Comparison of social indicators



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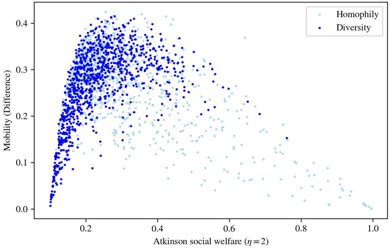

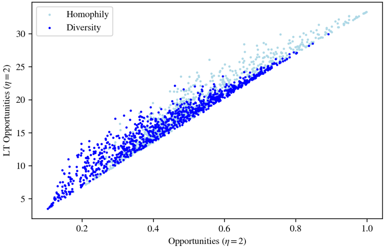

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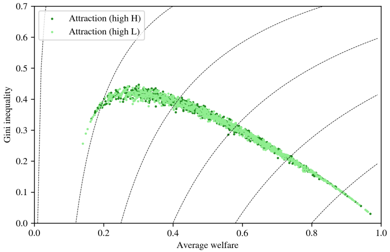
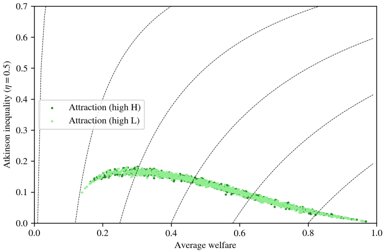
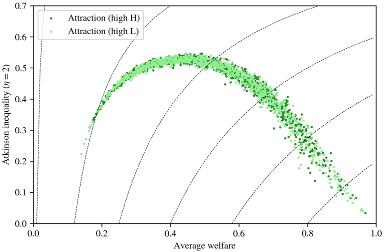
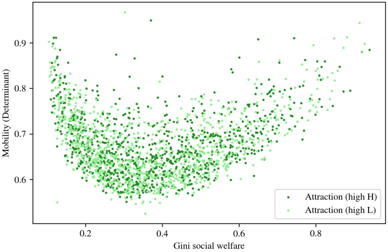
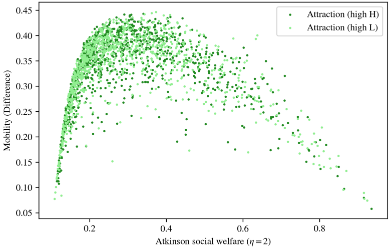


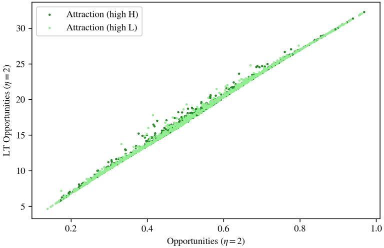






Comparison (cont'd)





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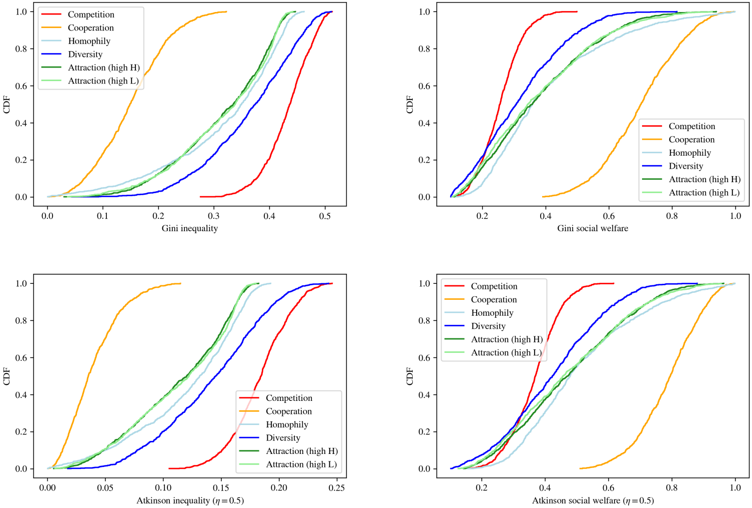

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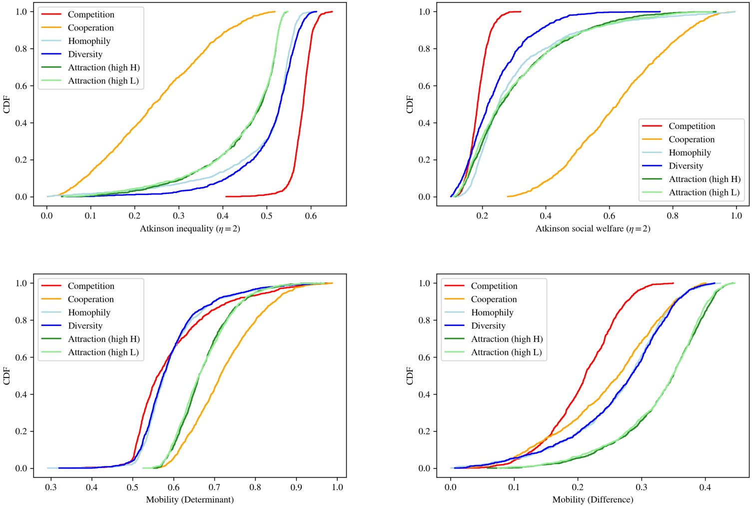

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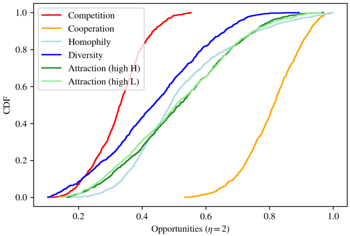
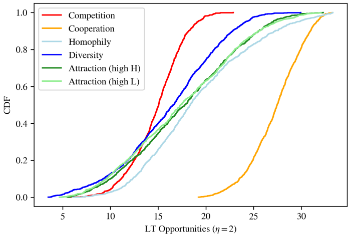
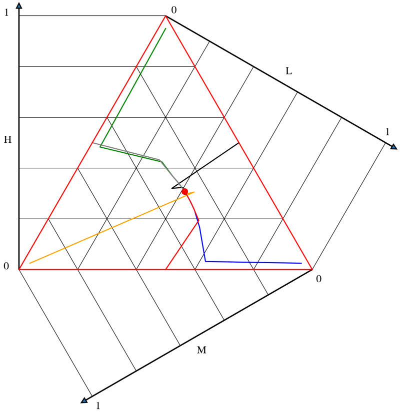
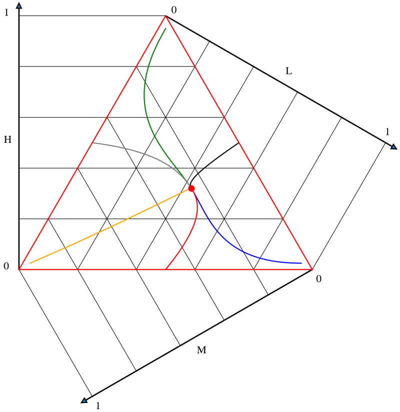




Pathways: competition

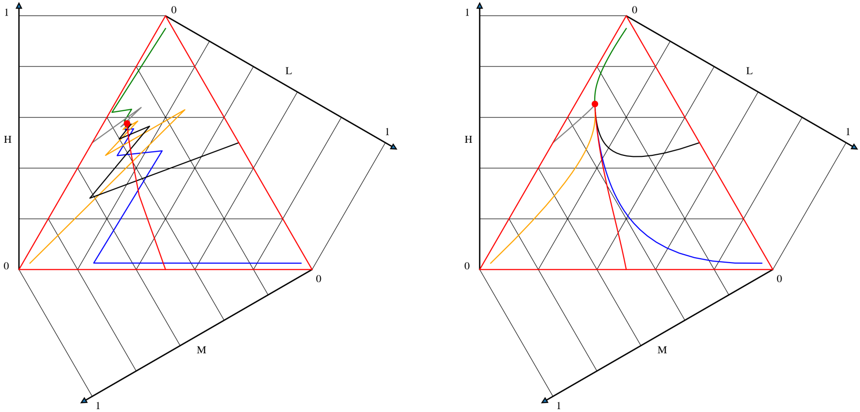


$\alpha^+=0.1, \alpha^-=0.4, \beta^+=0.2, \beta^-=0.3, \gamma^+=0.3, \gamma^-=0.1, s=2$



$\alpha^+=0.01, \alpha^-=0.04, \beta^+=0.02, \beta^-=0.03, \gamma^+=0.03, \gamma^-=0.01, s=2$

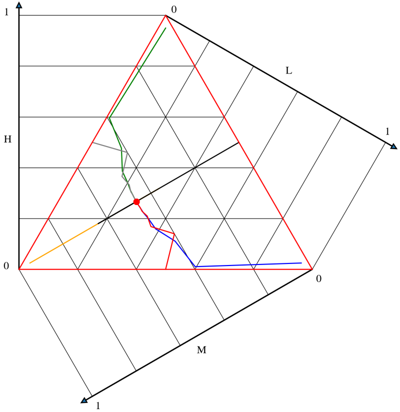
Pathways: cooperation



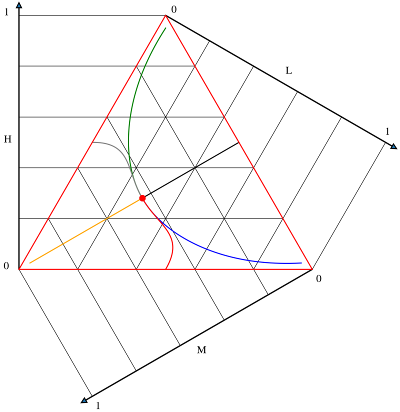
$\alpha^+ = 0.6, \alpha^- = 0.1, \beta^+ = 0.5, \beta^- = 0.2, \gamma^+ = 0.4, \gamma^- = 0.3, s = 2$

$\alpha^+ = 0.06, \alpha^- = 0.01, \beta^+ = 0.05, \beta^- = 0.02, \gamma^+ = 0.04, \gamma^- = 0.03, s = 2$

Pathways: Attraction

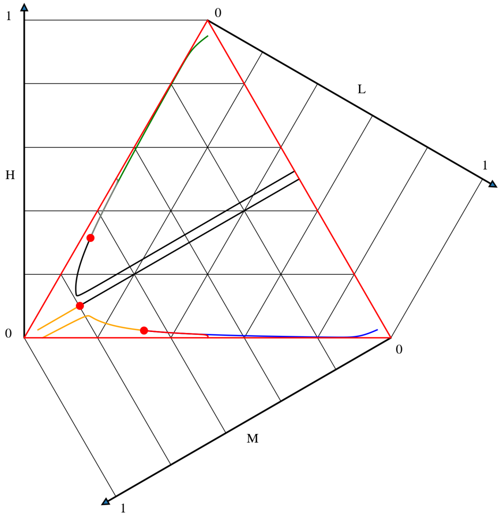


$\alpha^+ = 0.6$, $\alpha^- = 0.2$, $\beta^+ = 0.2$, $\beta^- = 0.2$, $\gamma^+ = 0.2$, $\gamma^- = 0.6$, $s = 2$



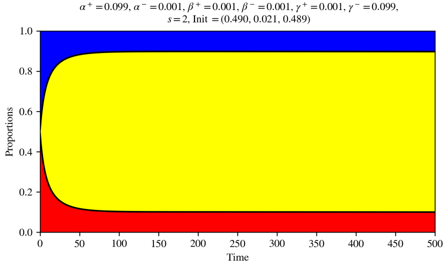
$\alpha^+ = 0.03$, $\alpha^- = 0.01$, $\beta^+ = 0.01$, $\beta^- = 0.01$, $\gamma^+ = 0.01$, $\gamma^- = 0.03$, $s = 2$

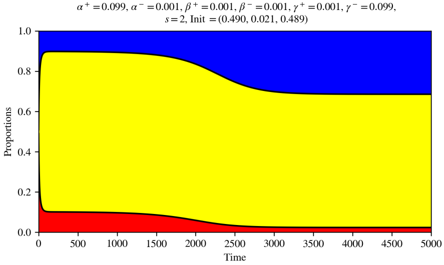
Pathways: Attraction



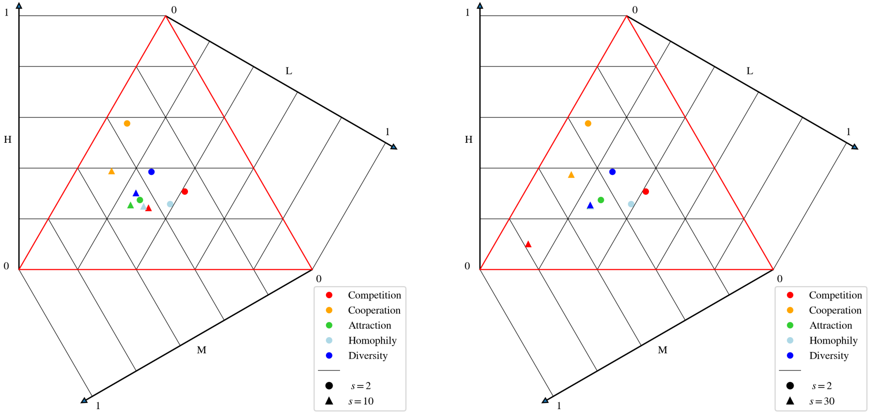
$\alpha^+ = 0.099, \alpha^- = 0.001, \beta^+ = 0.001, \beta^- = 0.001, \gamma^+ = 0.001, \gamma^- = 0.099, s = 2$

Pathways: attraction

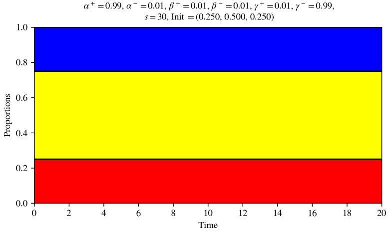


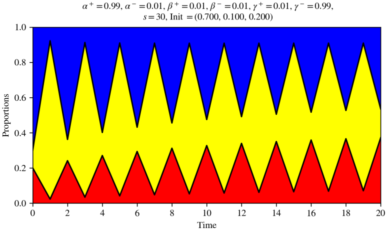


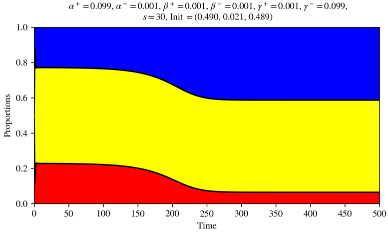
Increasing social contacts

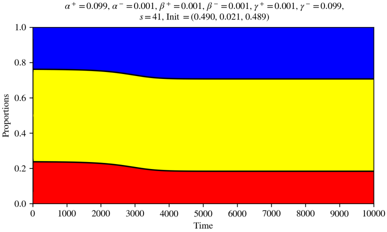


Increasing social contacts: attraction

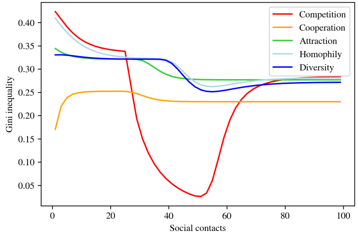


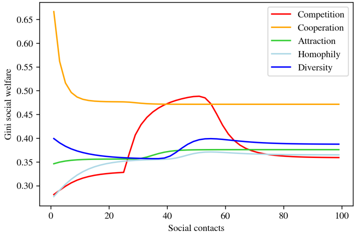


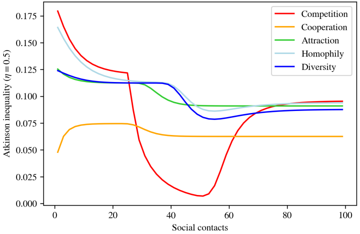


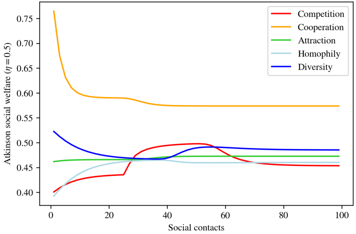


Increasing social contacts: comparisons

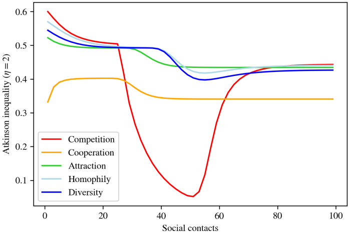


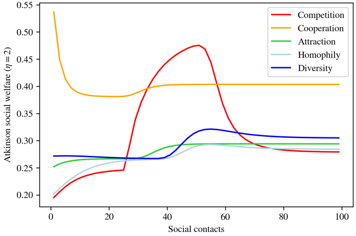


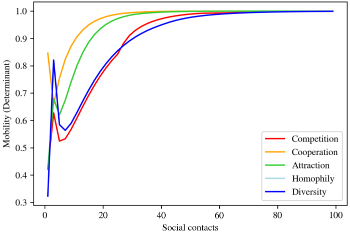


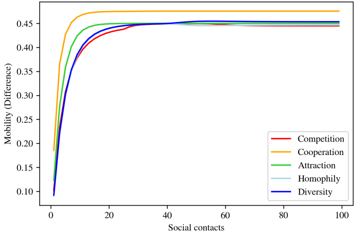


Increasing social contacts: comparisons

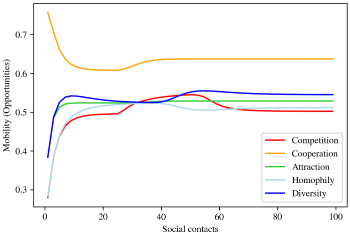


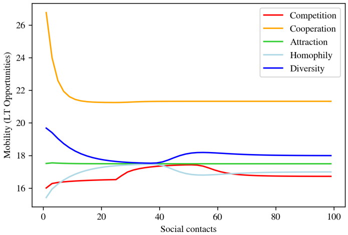




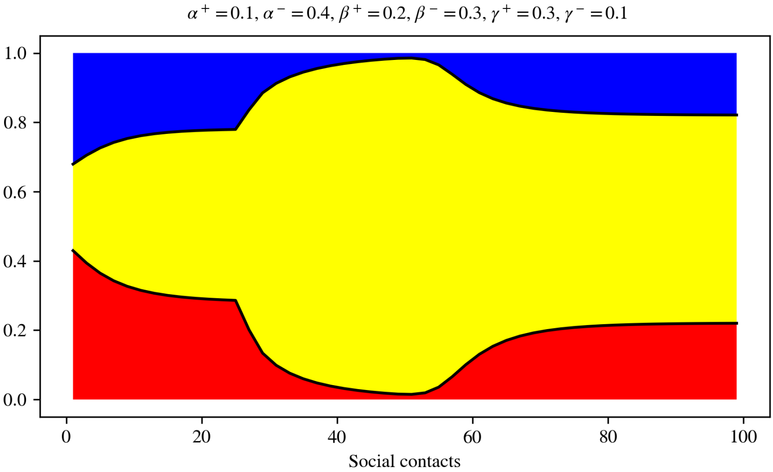


Increasing social contacts: comparisons

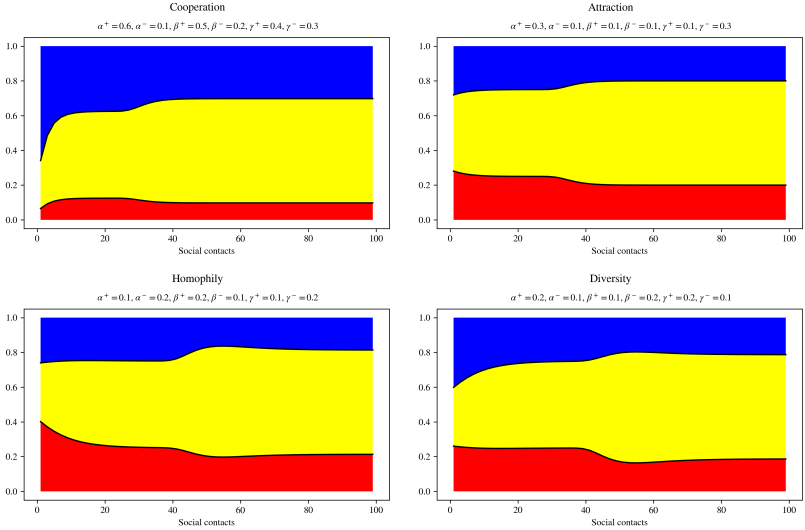




Increasing social contacts: competition



Increasing social contacts



Class meeting preferences

- Let π_{ij} denote the probability for someone in class i to meet someone from class j.
- Consistency requires that for each class $i, j = h, m, l$:

$$P_i \pi_{ij} = P_j \pi_{ji},$$

  where P_i, P_j denote the proportions of classes i, j in the population.
- We assume descending priority in the choice of contacts.

Meeting order

- Class h chooses the full vector $\pi_{hh}, \pi_{hm}, \pi_{hl}$, determining

$$\pi_{mh} = \frac{H}{M}\pi_{hm}$$

$$\pi_{lh} = \frac{H}{L}\pi_{hl}$$

- Class m chooses only π_{mm}, π_{ml},determining

$$\pi_{lm} = \frac{M}{L}\pi_{ml},$$

- Class l has no choice left, since

$$\pi_{ll} = 1 - \frac{H}{L}\pi_{hl} - \frac{M}{L}\pi_{ml}.$$

Dynamics and choice

- The new shock probabilities are:

$$\begin{bmatrix} p_h^- \\ p_m^\pm \\ p_l^+ \end{bmatrix} = \begin{bmatrix} \beta^- \pi_{hh} + \gamma^- (1 - \pi_{hh}) \\ \alpha^\pm \pi_{mh} + \beta^\pm \pi_{mm} + \gamma^\pm (1 - \pi_{mh} - \pi_{mm}) \\ \alpha^+ (\pi_{lh} + \pi_{lm}) + \beta^+ \pi_{ll} \end{bmatrix}.$$

- Individual in class $i = h, m, l$ has utility

$$U_i \left(p_h^-, p_m^\pm, p_l^+ \right) - C (\pi_{ih} - H, \pi_{im} - M)$$

where

$$U_i \left(p_h^-, p_m^\pm, p_l^+ \right) = O_i = (I - \beta T')_i^{-1} \begin{pmatrix} R_h \\ R_m \\ R_l \end{pmatrix}$$

$$C (\pi_{ih} - H, \pi_{im} - M) = \frac{c}{2} \left[(\pi_{ih} - H)^2 + (\pi_{im} - M)^2 + (\pi_{ih} - H + \pi_{im} - M)^2 \right]$$

with a parameter c such that choices are interior.

Competition: $(\alpha^+, \alpha^-, \beta^+, \beta^-, \gamma^+, \gamma^-) = (0.1, 0.4, 0.2, 0.3, 0.3, 0.1)$

Percentages	H	M	L
Benchmark	30.7	28.2	41.1
New distribution	33.9	24.7	41.3
$\pi_{h.}$	8.4	37.5	54.1
$\pi_{m.}$	51.4	2.1	46.5
$\pi_{l.}$	44.6	28.0	27.4

	p_h^-	p_m^+	p_m^-	p_l^+
Benchmark	16.1	21.0	24.8	14.1
New situation	11.7	19.5	25.8	12.8

Cooperation

Cooperation: $(\alpha^+, \alpha^-, \beta^+, \beta^-, \gamma^+, \gamma^-) = (0.6, 0.1, 0.5, 0.2, 0.4, 0.3)$

Percentages	H	M	L
Benchmark	57.6	34.3	8.1
New distribution	58.1	33.1	8.8
$\pi_{h.}$	73.0	25.6	1.4
$\pi_{m.}$	45.0	52.8	2.3
$\pi_{l.}$	9.8	9.4	80.9

	p_h^-	p_m^+	p_m^-	p_l^+
Benchmark	24.2	54.9	15.0	59.2
New situation	22.7	54.3	15.7	51.7

Attraction

Attraction: $(\alpha^+, \alpha^-, \beta^+, \beta^-, \gamma^+, \gamma^-) = (0.3, 0.1, 0.1, 0.1, 0.1, 0.3)$

Percentages	H	M	L
Benchmark	27.5	45.1	27.5
New distribution	29.8	41.1	29.1
$\pi_{h.}$	56.1	27.9	16.0
$\pi_{m.}$	20.3	78.5	1.2
$\pi_{l.}$	17.4	1.8	80.8

	p_h^-	p_m^+	p_m^-	p_l^+
Benchmark	24.5	15.5	15.5	24.5
New situation	18.8	14.1	10.2	13.6

Homophily

Homophily: $(\alpha^+, \alpha^-, \beta^+, \beta^-, \gamma^+, \gamma^-) = (0.1, 0.2, 0.2, 0.1, 0.1, 0.2)$

Percentages	H	M	L
Benchmark	25.8	35.6	38.6
New distribution	41.5	35.2	23.3
$\pi_{h.}$	66.5	22.7	10.8
$\pi_{m.}$	26.8	72.7	0.5
$\pi_{l.}$	11.6	0.5	87.9

	p_h^-	p_m^+	p_m^-	p_l^+
Benchmark	17.4	13.6	16.4	13.9
New situation	13.4	17.3	12.7	18.0

Diversity

Diversity: $\left(\alpha^{+}, \alpha^{-}, \beta^{+}, \beta^{-}, \gamma^{+}, \gamma^{-}\right) = (0.2, 0.1, 0.1, 0.2, 0.2, 0.1)$

Percentages	H	M	L
Benchmark	38.6	35.6	25.8
New distribution	50.0	36.1	13.9
$\pi_{h.}$	27.8	47.2	25.0
$\pi_{m.}$	65.4	4.9	29.7
$\pi_{l.}$	48.5	41.5	10.1

	p_h^-	p_m^+	p_m^-	p_l^+
Benchmark	13.9	16.4	13.6	17.4
New situation	12.8	19.5	10.5	26.7

- Each class i has its own probabilities $\alpha_i^{\pm}, \beta_i^{\pm}, \gamma_i^{\pm}$, altering the probability matrix as follows:

$$P = \begin{bmatrix} \beta_h^- & \gamma_h^- & \gamma_h^- \\ \alpha_m^{\pm} & \beta_m^{\pm} & \gamma_m^{\pm} \\ \alpha_l^+ & \alpha_l^+ & \beta_l^+ \end{bmatrix}.$$

- Utility

$$U_i\left(p_h^-, p_m^{\pm}, p_l^+\right) - C\left(\alpha_i^{\pm} - \alpha^{\pm}, \beta_i^{\pm} - \beta^{\pm}, \gamma_i^{\pm} - \gamma^{\pm}\right)$$

with

$$C\left(\alpha_i^{\pm}, \beta_i^{\pm}, \gamma_i^{\pm}\right) = \frac{c}{2} \sum_{x=\alpha_i^{\pm}, \beta_i^{\pm}, \gamma_i^{\pm}} (x_i - x)^2 .$$

c chosen such that the solution remains interior but nevertheless comes close to a corner solution

Illustration with competition

Class distribution	H	M	L
Benchmark	30.7	28.2	41.1
New distribution	41.9	26.1	32.0

Transition probabilities	p_h^-	p_m^+	p_m^-	p_l^+
Benchmark	16.1	21.0	24.8	14.1
New situation	10.8	21.6	25.8	17.7

Shock probabilities	α^+	β^+	γ^+	α^-	β^-	γ^-
Benchmark	10	20	30	40	30	10
β_h^-, γ_h^-					23.9	1.5
$\alpha_m^+, \beta_m^+, \gamma_m^+, \alpha_m^-, \beta_m^-, \gamma_m^-$	13.1	21.9	32.4	37.6	28.5	8.2
α_l^+, β_l^+	15.4	22.5				

Utilities	H	M	L
With zero efforts	18.0	16.4	15.0
With efforts	19.0	18.5	17.0

Introducing externalities

$$P = \begin{bmatrix} \beta_h^- & \gamma_h^- & \gamma_h^- \\ \alpha_m^\pm & \beta_m^\pm & \gamma_m^\pm \\ \alpha_l^+ & \alpha_l^+ & \beta_l^+ \end{bmatrix}$$

$$+\kappa \begin{bmatrix} \alpha_m^+ + \alpha_l^+ - 2\alpha^+ & \alpha_m^+ + \alpha_l^+ - 2\alpha^+ & \alpha_m^+ + \alpha_l^+ - 2\alpha^+ \\ \mp\left(\gamma^- - \gamma_h^- + \alpha_l^+ - \alpha^+\right) & \mp\left(\gamma^- - \gamma_h^- + \alpha_l^+ - \alpha^+\right) & \mp\left(\gamma^- - \gamma_h^- + \alpha_l^+ - \alpha^+\right) \\ \gamma_h^- + \gamma_m^- - 2\gamma^- & \gamma_h^- + \gamma_m^- - 2\gamma^- & \gamma_h^- + \gamma_m^- - 2\gamma^- \end{bmatrix}$$

Illustration with competition

Class distribution	H	M	L
Benchmark	30.7	28.2	41.1
New distribution	31.5	26.5	42.0

Transition probabilities	p_h^-	p_m^+	p_m^-	p_l^+
Benchmark	16.1	21.0	24.8	14.1
New situation	12.6	18.3	28.5	14.9

Shock probabilities	α^+	β^+	γ^+	α^-	β^-	γ^-
Benchmark	10	20	30	40	30	10
β_h^-, γ_h^-					26.1	1.6
$\alpha_m^+, \beta_m^+, \gamma_m^+, \alpha_m^-, \beta_m^-, \gamma_m^-$	12.6	22.1	33.4	38.3	28.6	7.8
α_l^+, β_l^+	15.6	24.0				

Utilities	H	M	L
With zero efforts	18.0	16.4	15.0
With efforts	16.7	15.7	14.1

Illustration with cooperation

Class distribution	H	M	L
Benchmark	57.6	34.3	8.1
New distribution	66.5	26.4	7.1

Transition probabilities	p_h^-	p_m^+	p_m^-	p_l^+
Benchmark	24.2	54.9	15.0	59.2
New situation	14.7	54.6	11.4	57.4

Shock probabilities	α^+	β^+	γ^+	α^-	β^-	γ^-
Benchmark	60	50	40	10	20	30
β_h^-, γ_h^-					3.8	21.8
$\alpha_m^+, \beta_m^+, \gamma_m^+, \alpha_m^-, \beta_m^-, \gamma_m^-$	63.6	51.4	40.4	1.6	16.6	29.1
α_l^+, β_l^+	61.9	50.1				

Utilities	H	M	L
With zero efforts	25.5	24.9	24.2
With efforts	26.2	26.7	26.3

Conclusion

- This model can be part of a toolkit and can be enriched in variants (microfoundation of meetings and institutions, clusters...)
- The taxonomy sheds new light on competition and cooperation, homophily, etc. and this can help designing institutions that implement these interaction types
- Cooperation enhances average welfare, reduces inequality, boosts mobility, reduces the harm of efforts to do one's best
- Homophily, compared to diversity, reduces opportunities to meet helpers, but may be advantageous for average welfare, inequality and mobility (except pure transition mobility) when the benefits of meeting an equal are high

Conclusion (cont'd)

- The model generally has a unique stable steady state, but attraction offers the possibility of near-miss convergence
- Social contacts have non-linear effects on the social structure
- Efforts to meet the right people pay off at the individual level but may fail to change the social structure, when the "right people" are sought after by all classes
- Efforts to do one's best may have negative externalities on others—but even in this respect, competition and cooperation seem to differ