Significance statement

Introduction

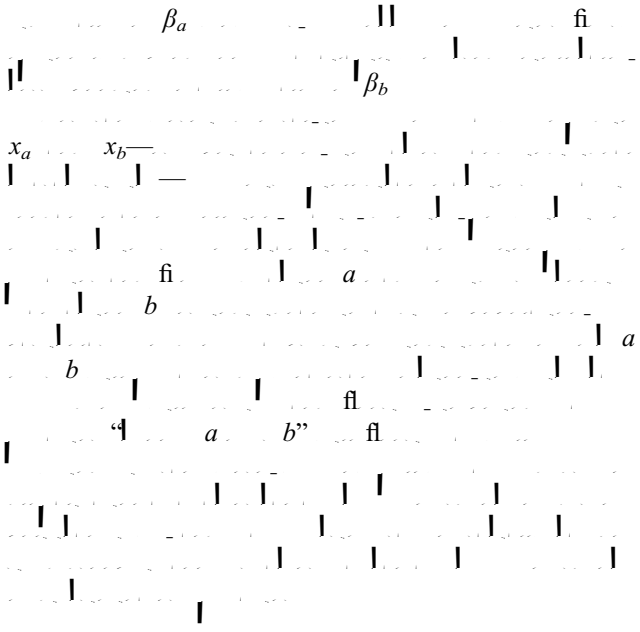
Modeling framework

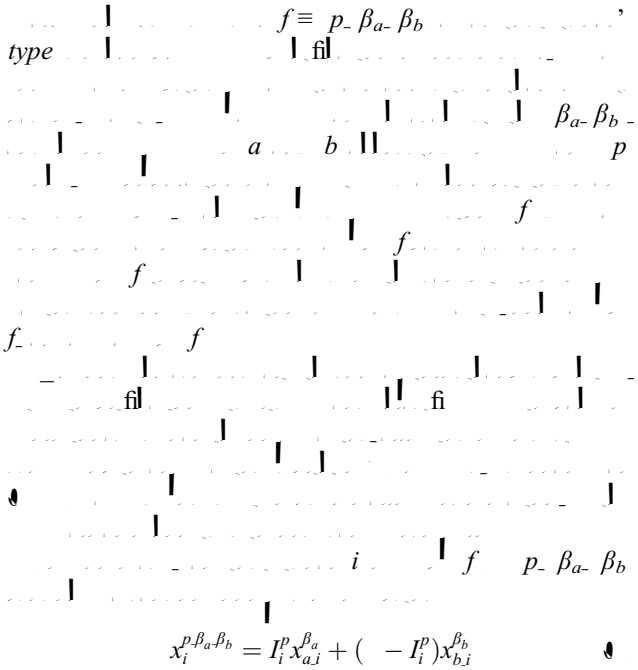
Formal model

$$x_a = \beta_a \lambda + (\quad - \beta_a)\lambda$$
$$x_b = \beta_b \lambda + (\quad - \beta_b)\lambda$$

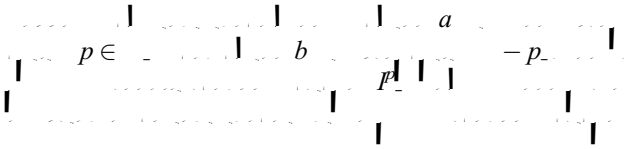
Table 1. Model parameters and constraints.

Parameters/Constraints	Explanation
a and b	Two actions for each individual to choose from.
$x_a \geq 0$ and $x_b \geq 0$	Random numbers of offspring that correspond to choices a and b.
$\lambda_1 \geq 0$ and $\lambda_2 \geq 0$	Two environmental factors that determine fitness, independent and identically distributed (IID) over time and identical for all individuals in a given generation.
$\beta_a \in [0, 1]$ and $\beta_b \in [0, 1]$	Individual characteristics that determine the loading of fitness on factors.
$p \in [0, 1]$	Individual behavior, used as the probability to choose action a.
$f \equiv (p, \beta_a, \beta_b)$	An individual's type, which is the unit of selection in evolution because it completely characterizes an individual.
$\mu(p, \beta_a, \beta_b)$	Log-geometric-average population growth rate for individuals of type (p, β_a, β_b).
$f^* = (p^*, \beta_a^*, \beta_b^*))$	The growth-optimal type that yields the fastest population growth rate.



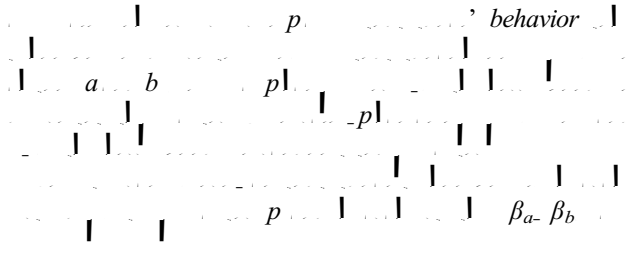


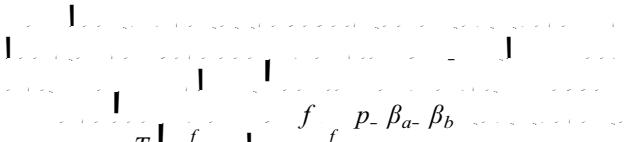
Individual behavior



$$x^p = I^p x_a + (\quad - I^p) x_{b_}$$

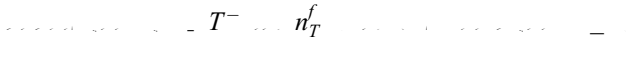
$$I^p = \begin{cases} \quad\quad p \\ \quad - p. \end{cases}$$





$$x_i^{p_\beta_a_\beta_b} = I_i^p x_{a_i}^{\beta_a} + (\quad - I_i^p) x_{b_i}^{\beta_b}$$

$$x_{a_i}^{\beta_a} = \beta_a \lambda \quad + (\quad - \beta_a) \lambda$$
$$x_{b_i}^{\beta_b} = \beta_b \lambda \quad + (\quad - \beta_b) \lambda \qquad 8$$

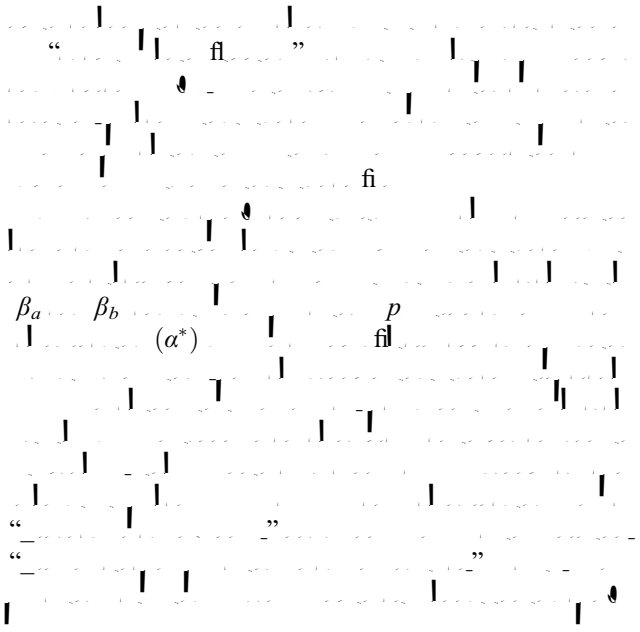


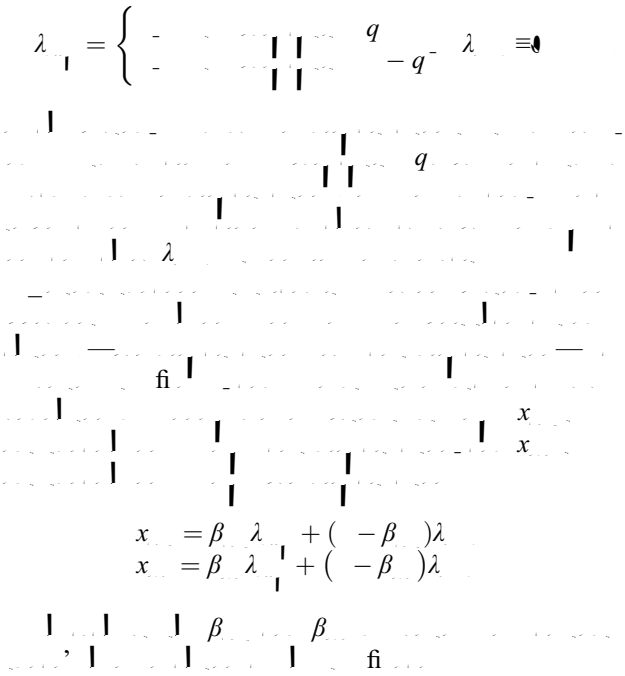
Population dynamics

$$\mu(p_\beta_a_\beta_b) = \mathbb{E}\Big[\quad \Big(px_a^{\beta_a} + (\quad - p)x_b^{\beta_b}\Big)\Big]_$$

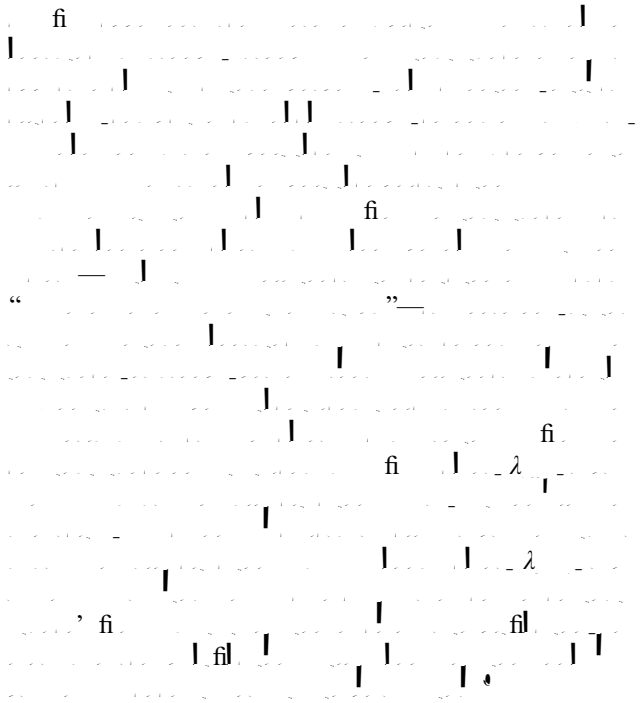
$$\alpha \quad = p\beta_a + (\quad - p)\beta_b$$
$$\alpha \quad = p(\quad - \beta_a) + (\quad - p)(\quad - \beta_b)$$

$$\mu(p_\beta_a_\beta_b) = \mathbb{E}[\quad (\alpha\ \lambda\ + (\quad - \alpha\ )\lambda\ )]_$$





Binary choice model of political polarization



A simple example

Proposition 2. *Under assumptions (A1) and (A2) and the environment speci ed by and , the population growth rate in can be evaluated explicitly as*

$$\mu \quad (p) \quad = q \quad (\quad - p) + (\quad - q) \quad (\quad + p)$$
$$\mu \quad (p) \quad = q \quad (\quad + p) + (\quad - q) \quad (\quad - q) \quad -$$

and the behavior (value of p) that maximizes this growth rate is

$$p \quad = \begin{cases} - & \text{if } q \leq - \\ - 8q - & \text{if } - \quad q \quad - \\ - & \text{if } q \geq - \end{cases} \qquad 8$$

$$p \quad = \begin{cases} - & \text{if } q \leq - \\ 8q - \quad - & \text{if } - \quad q \quad - \\ - & \text{if } q \geq - \end{cases}$$

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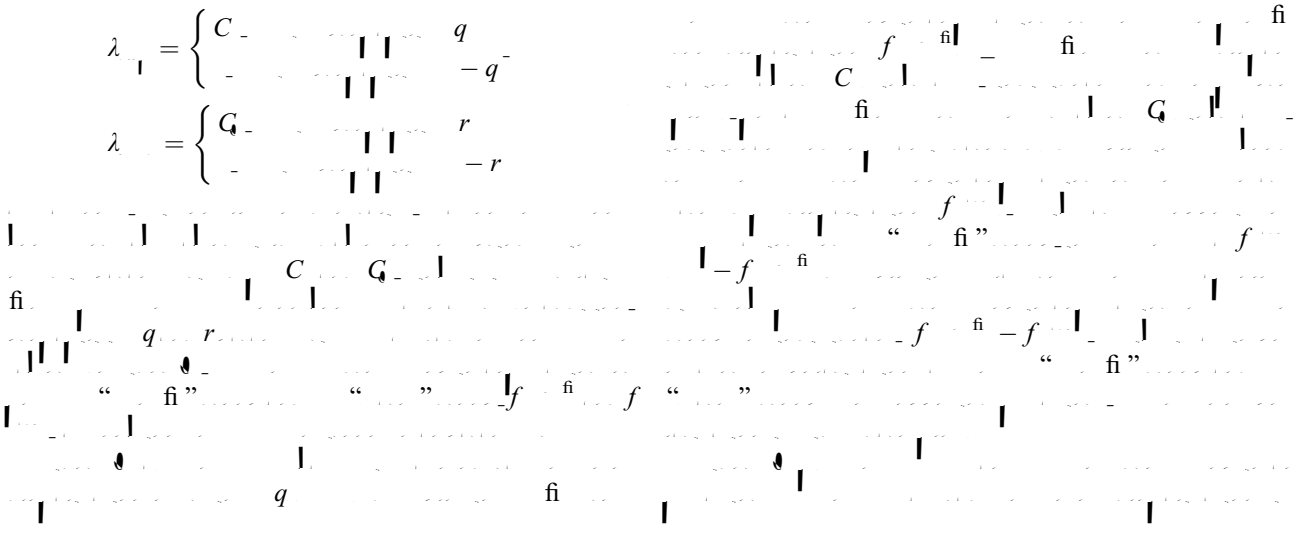
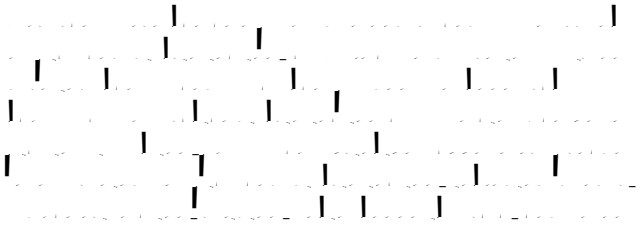
Figure 2. Growth-optimal behaviors for both the "Benefit" group and the "Harm" group, $f^{Benefit}$ and f^{harm}, as functions of environmental parameters. (2a): moderate globalization with $q = 0.5$. (2b): high globalization with $q = 0.9$. The first row shows $f^{Benefit}$; the second row shows f^{harm}; the last row shows the absolute difference, that is, polarization: $|f^{Benefit} - f^{harm}|$.



Binary choice model of bias and discrimination



A simple example

$$\lambda_A = \begin{cases} q \\ -q \end{cases}$$

$$\lambda_T = \begin{cases} r \\ -r \end{cases}$$

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