Building on shifting sands: Complex contagion and negative ties hinder malaria outdoor preventive measure adoption in a hard-to-reach population in Meghalaya, India

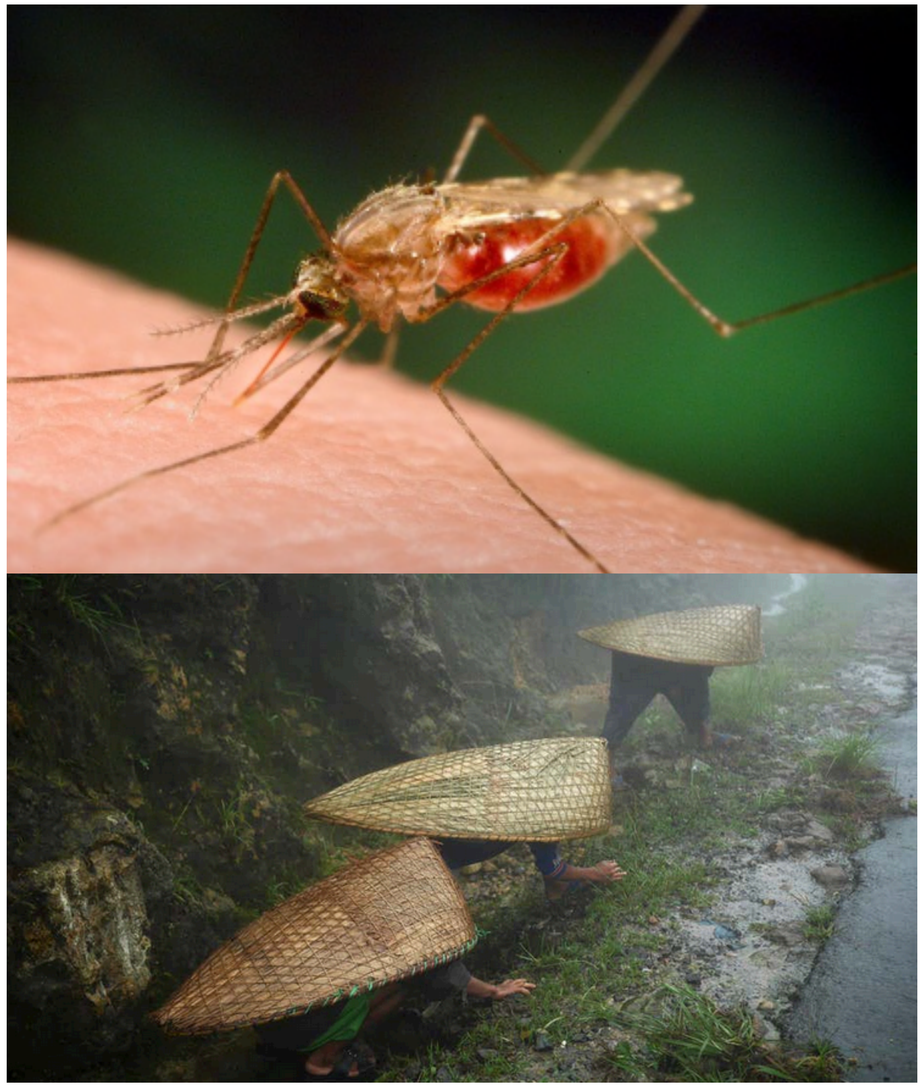
NYU ABM Lab - BehaveLab Meeting,
New York University, 4 June, 2025

Federico Bianchi*, Elisa Bellotti, Francesco Renzini*, …, Sara Albert*****

* Behave Lab, Department of Social and Political Sciences, University of Milan, Italy
** Mitchell Centre for Social Network Analysis and Department of Sociology, University of Manchester, UK
*** Indian Institute of Public Health in Shillong, India

Low adoption of malaria preventive measures in hard-to-reach populations

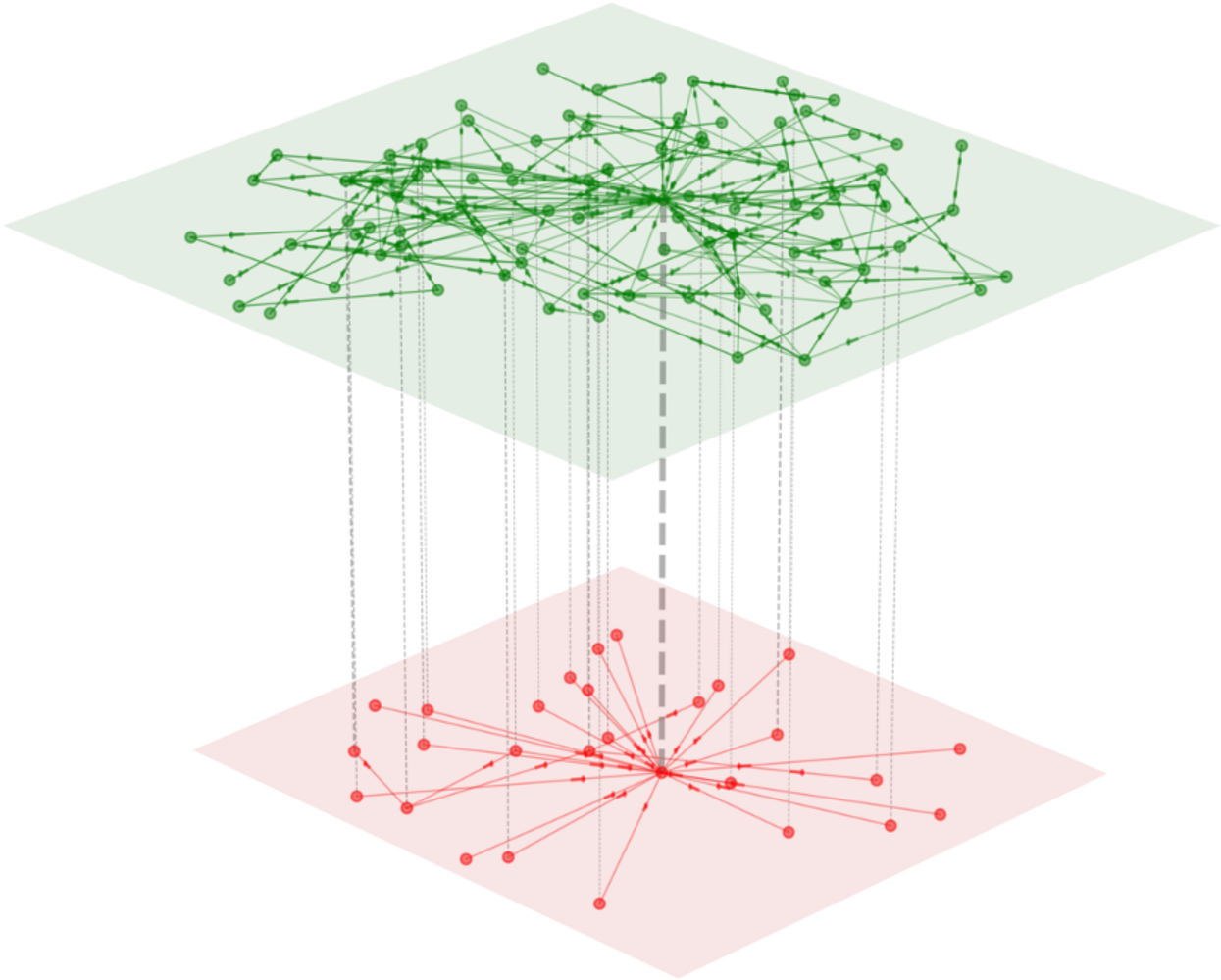
- **Malaria** is still to be fully eradicated: Epicenters are often located among **hard-to-reach populations** in the Global South
- Geographical marginalization + low socio-economic status —> poor access to health care
- resistance to instituzionaled health practices (cultural/religious beliefs) despite top-down policy —> **low adoption rate of key preventive measures**
- **Meghalaya (North-Eastern India)**: mountainous area with patches of tropical forest - **Tribal population** (Garo and Khasi-Jaintia) —> **lack of fine-grained data**



Data

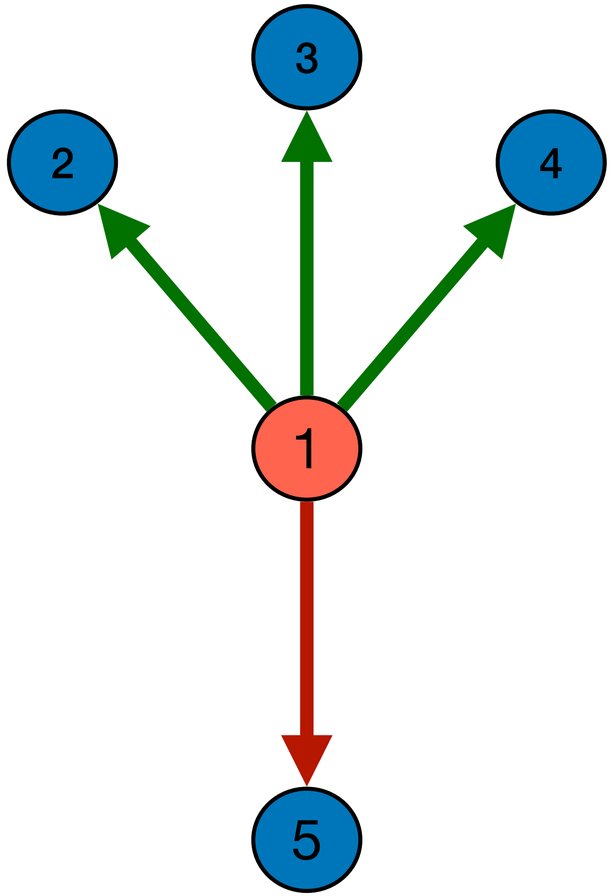
- Data collection: 2020-2021 face-to-face questionnaire administration
- Network data:
  - **Positive ties**: Who do you talk to about health?
  - **Negative ties**: Who do you avoid talking to about health?
- Individual data: **Cream use** (yes/no)

- **cream adoption rate = 14.96%**
- # individuals (nodes) = 98
- # positive ties = 272
- avg. degree (positive ties) = 2.78
- # negative ties = 27
- avg. degree (negative ties) = 0.28



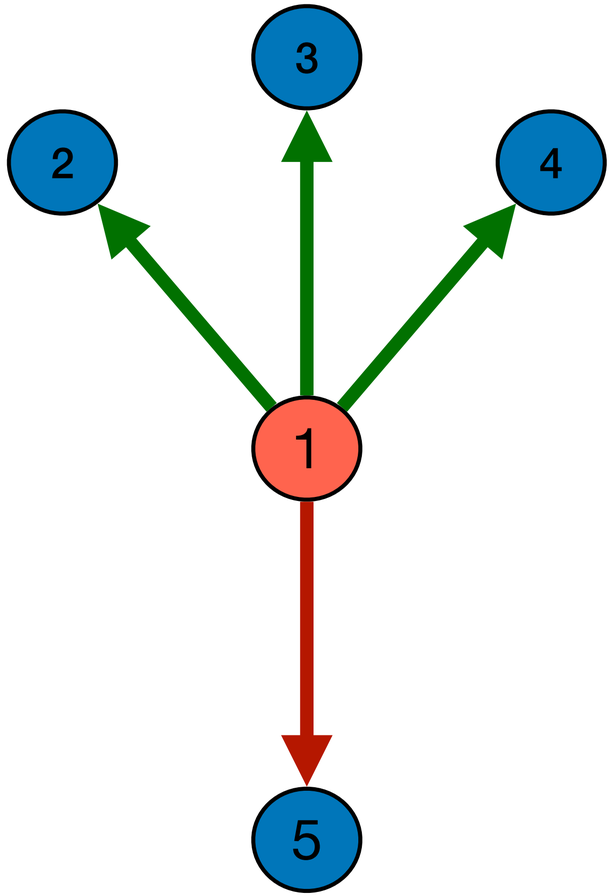
Complex contagion + negative influence

- Obstacles to preventive measure (**insecticidal cream**) **adoption**:
  - stigmatized (misalignment with traditional health culture)
  - easily observable behaviour
  - small, tight community (tribal villages)
- **Dual-side diffusion mechanism**:
  - **Complex (threshold-based) contagion**: strong reinforcement from **adoption** by **positive ties** (Centola & Macy, 2007)
  - **Negative influence**: **adoption** by **negative contacts**
- Assuming **idiosyncratic** case characteristics:
  - positive impact of within-household adoption (fixed effect)
  - Positive tie with ASHA (Accredited Social Health Activist) increases propensity to use
  - Positive tie with traditional healer decreases propensity to use

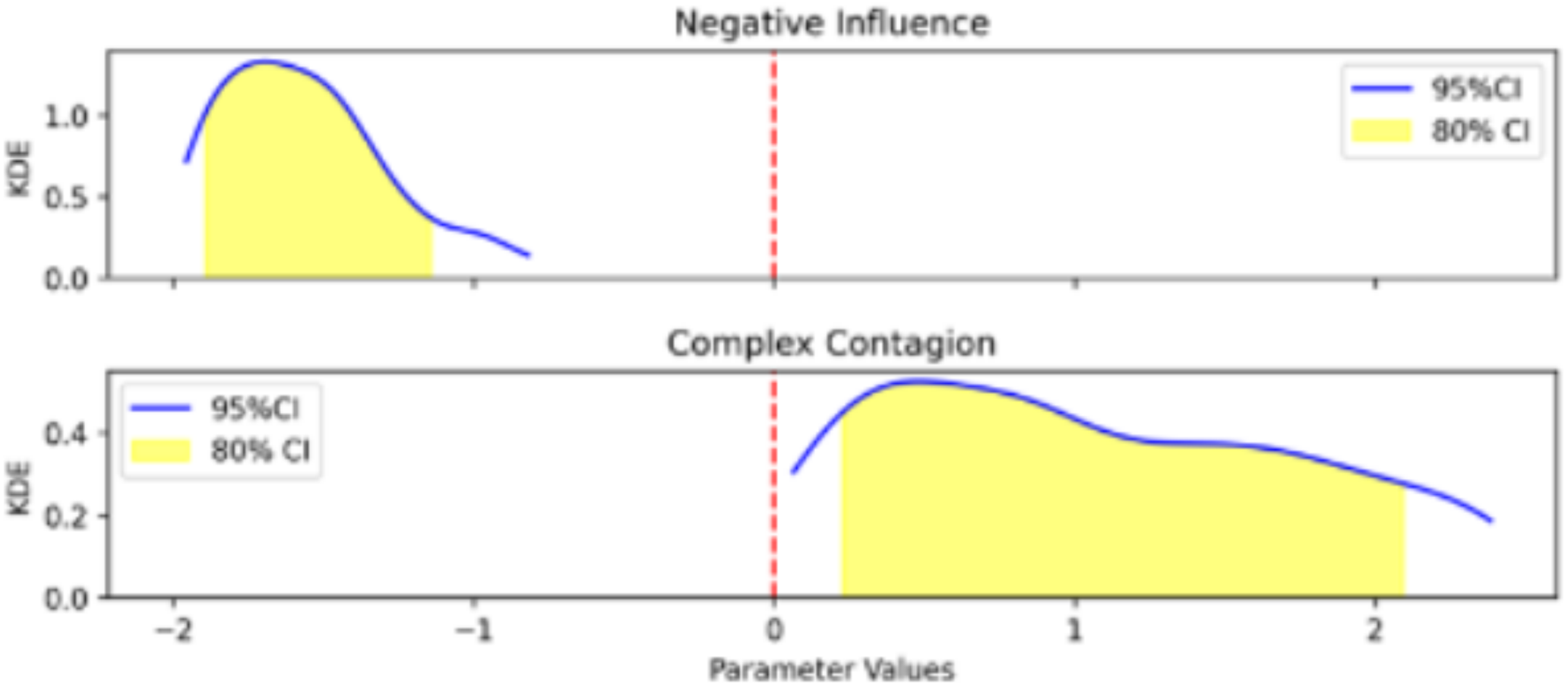


ABM of complex contagion + negative influence

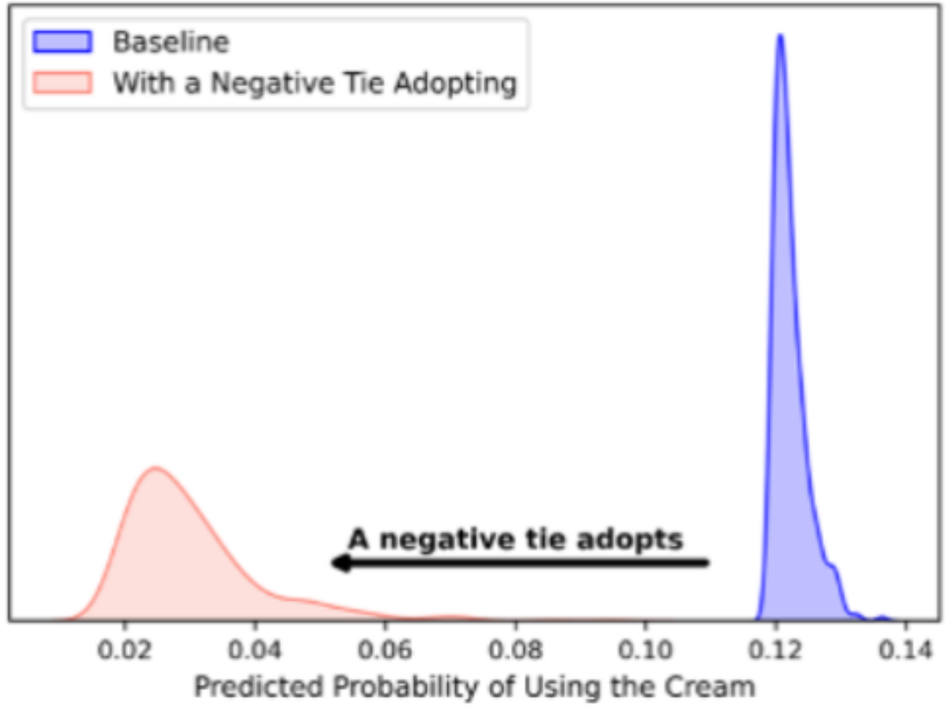
- **ABM of the diffusion** process in the empirically-observed networks (Bianchi & Renzini, *forthcoming*)
- Model of villagers' **cream use** as a binary-choice model (Mc Fadden, 1978): **logistic objective function** of personal networks' composition
- **Estimating**:
  - **threshold levels** for cream use contagion
  - impact of threshold-based **positive influence**
  - impact of **negative influence** (= adoption by one negative contact)
- **Assuming:**
  - positive impact of within-household adoption (fixed effect)
  - ASHA and traditional healers as stubborn agents

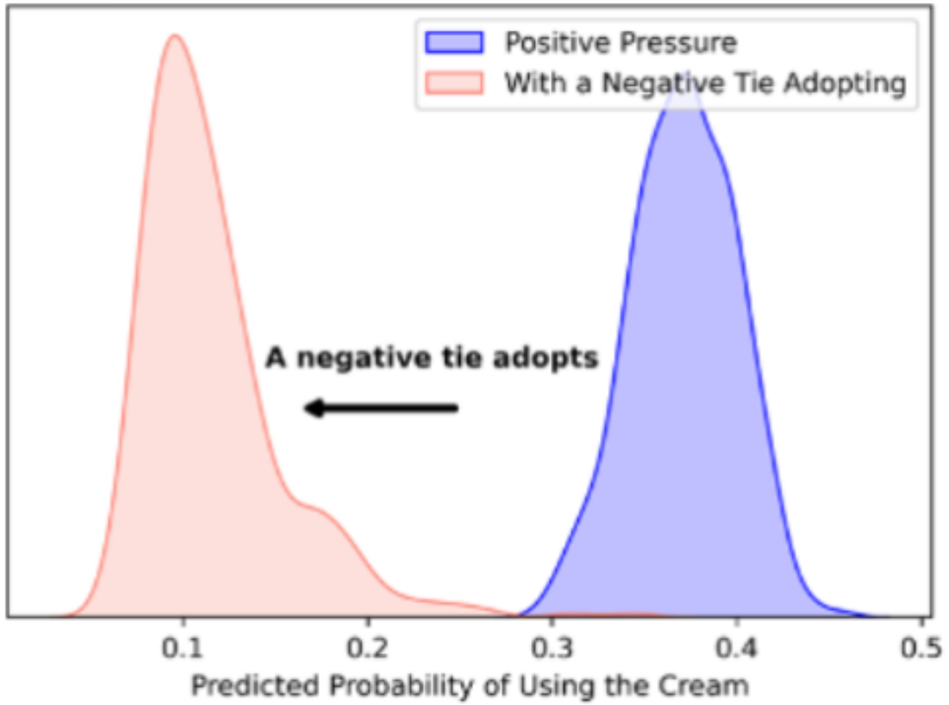


Impact of diffusion mechanism

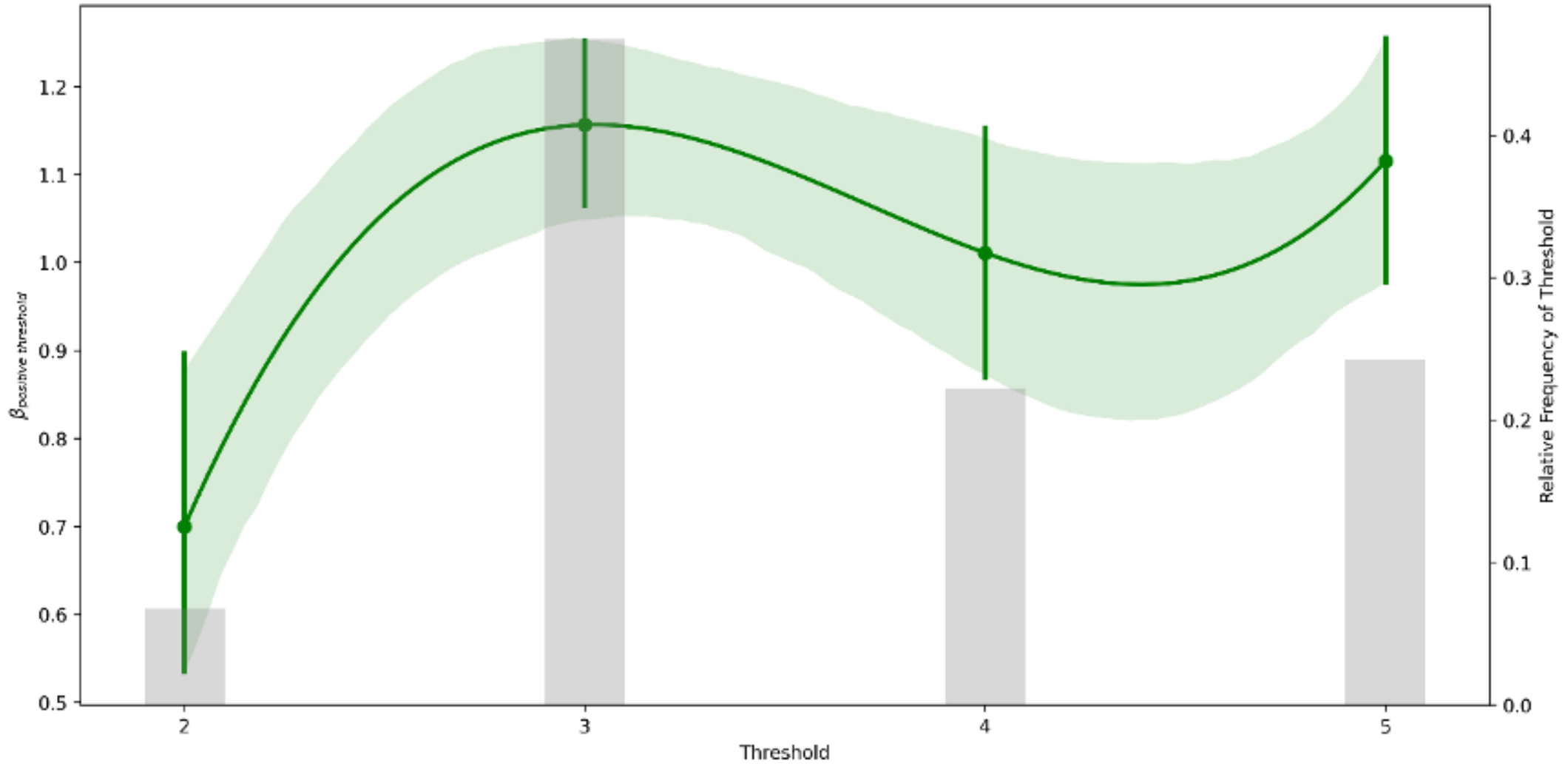


Impact of diffusion mechanism



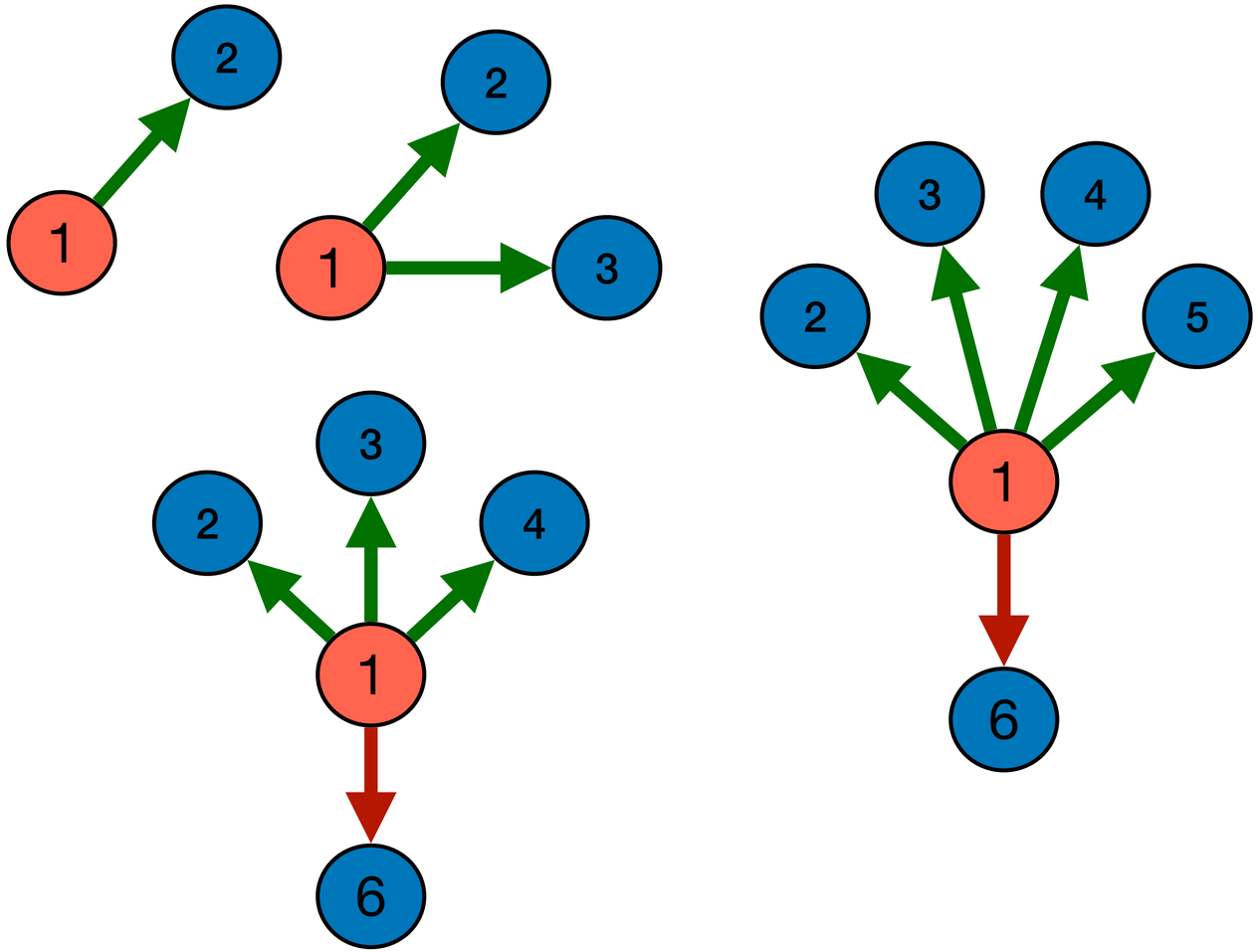


Estimated threshold

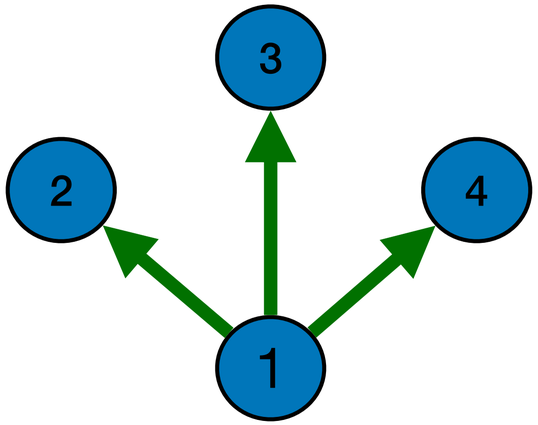


Building on shifting sands

No adoption



Adoption

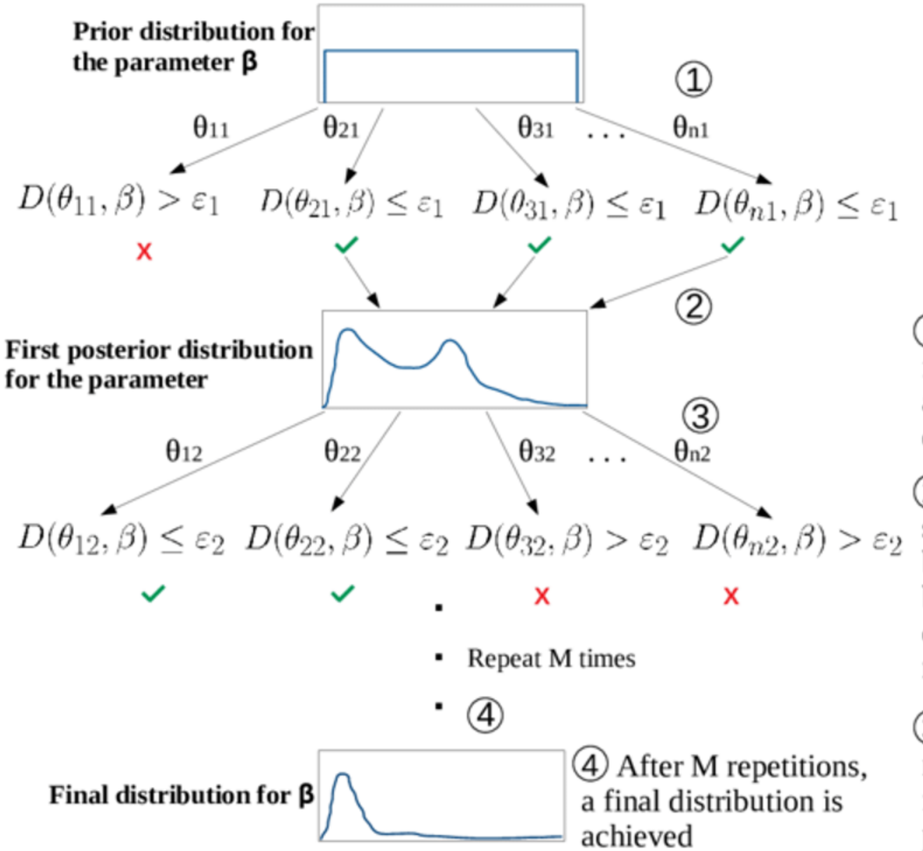


Estimation method

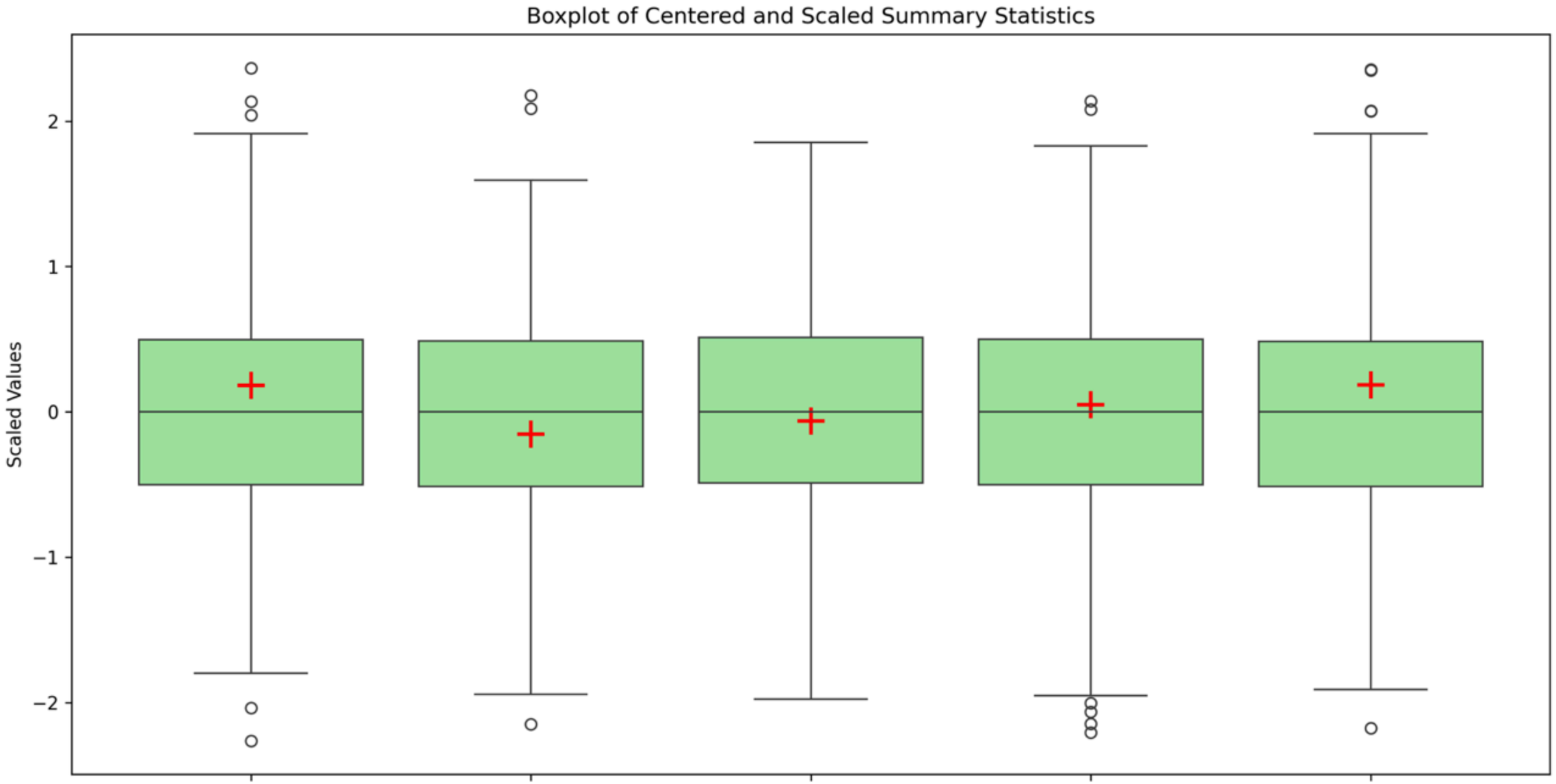
Approximate Bayesian Computation (Hartig et al., 2011)

Weakly informative priors (tested with predictive checks)

- Baseline: uniform [-3, 0]
- Threshold: {2, 3, 4, 5}
- Positive influence: uniform [0, 2.5]
- Negative influence: uniform [-2, 0]

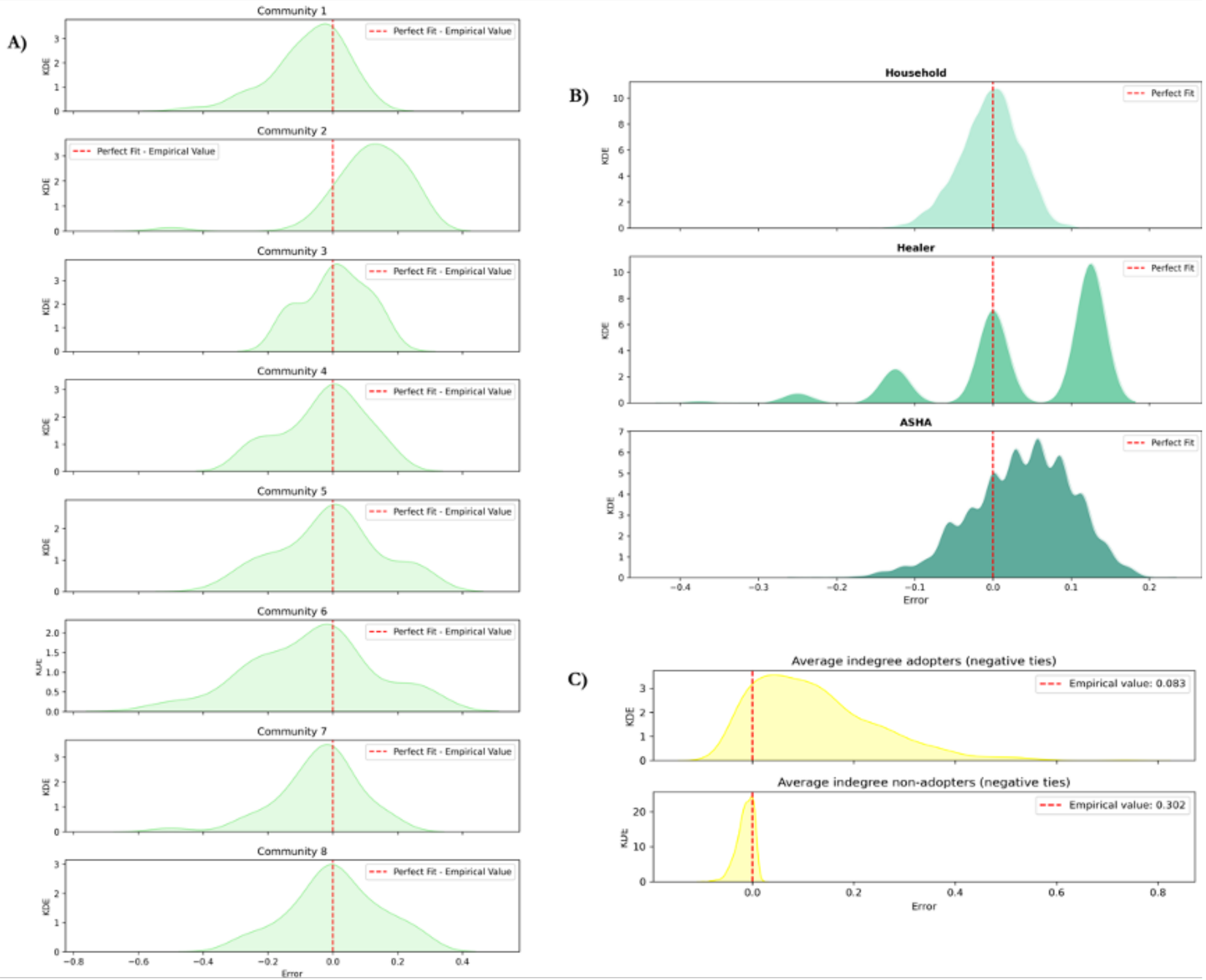


Model fit



0.05 | 0.06 | 2.39 | 2.42 | 14.96%

Model fit


A)
Community 1
Community 2
Community 3
Community 4
Community 5
Community 6
Community 7
Community 8
Perfect Fit - Empirical Value
KDE
Error
B)
Household
Healer
ASHA
Perfect Fit
C)
Average indegree adopters (negative ties)
Empirical value: 0.083
Average indegree non-adopters (negative ties)
Empirical value: 0.302

Conclusions

- Adoption of collectively beneficial, yet stigmatized behaviour might be hindered by a combination of two pulling forces in one's personal network:
  - Need for **strong reinforcement** (high threshold-based **prevalence** of the behaviour among trusted people)
  - High sensitivity to **negative influence**
- **(empirical) ABM** can reliably estimate **unobserved behaviour** on fine-grained (network) data

Website	https://federico-bianchi.github.io/
Mail	federico.bianchi1@unimi.it
BlueSky	@federicobianchi.bsky.social
X	@federico_fb

Impact of diffusion mechanism