Complex contagion and negative influence in the adoption of malaria preventive measures: An empirical agent-based model

16th Annual Conference of the International Network of Analytical Sociology,
30-31 May, 2024, Leipzig

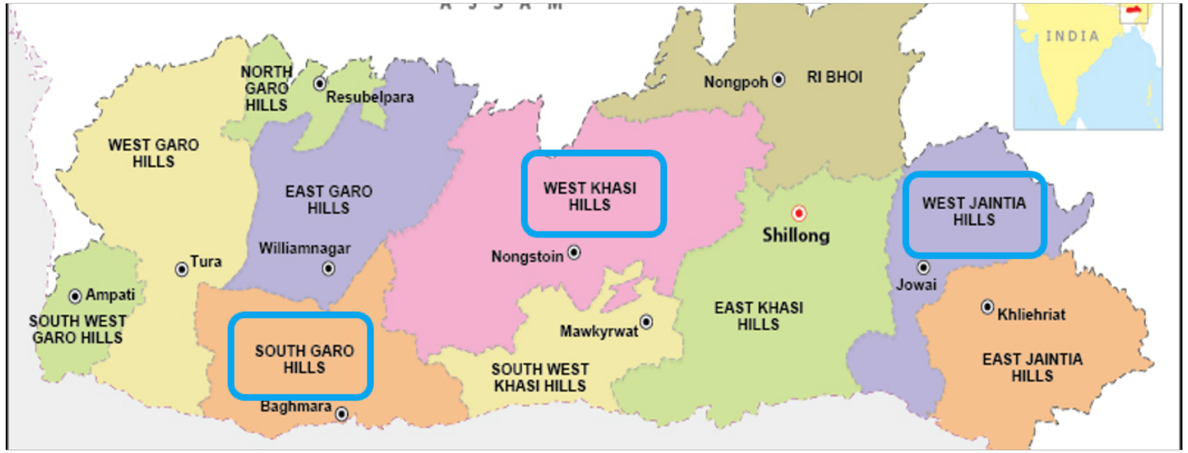
Elisa Bellotti*, Federico Bianchi & Francesco Renzini****

* Mitchell Centre for Social Network Analysis and Department of Sociology, University of Manchester, UK

** Behave Lab, Department of Social and Political Sciences, University of Milan, Italy

Malaria prevention in hard-to-reach populations

- WHO goal: eradicating malaria by 2030
- **Hard-to-reach populations** still face a high risk of infection —> policy needs to be designed in cooperation with local population
- **10 villages** in **Meghalaya, North-Eastern India** (mountainous area with patches of tropical forest)
- Hard-to-reach tribal population (Garo and Khasi-Jaintia): geographical **marginalization**, low socio-economic status, **poor access to health care**, resistance to instituzionaled health practices because of cultural/religious beliefs

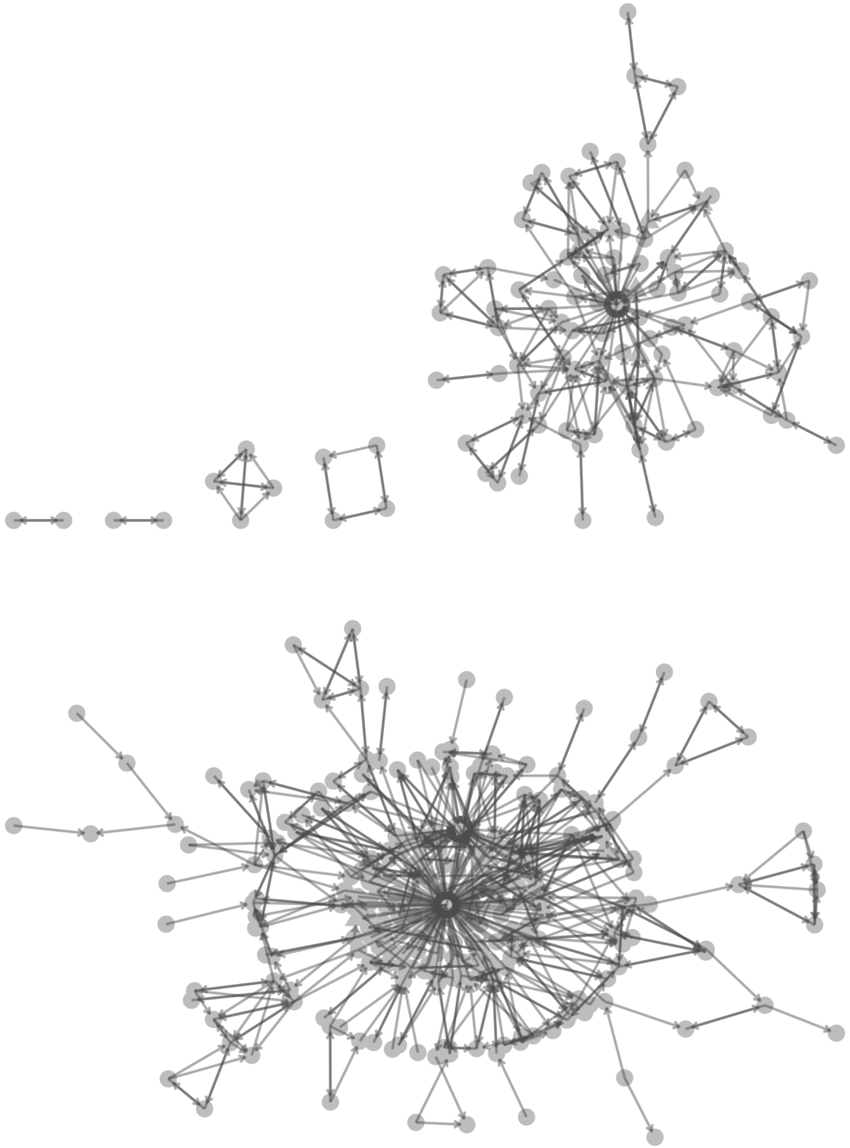


Preventive measures

- Measures of **indoor biting** prevention are highly adopted
- **Low adoption of outdoor biting prevention measures** (spray, body cream, boots, special clothing)

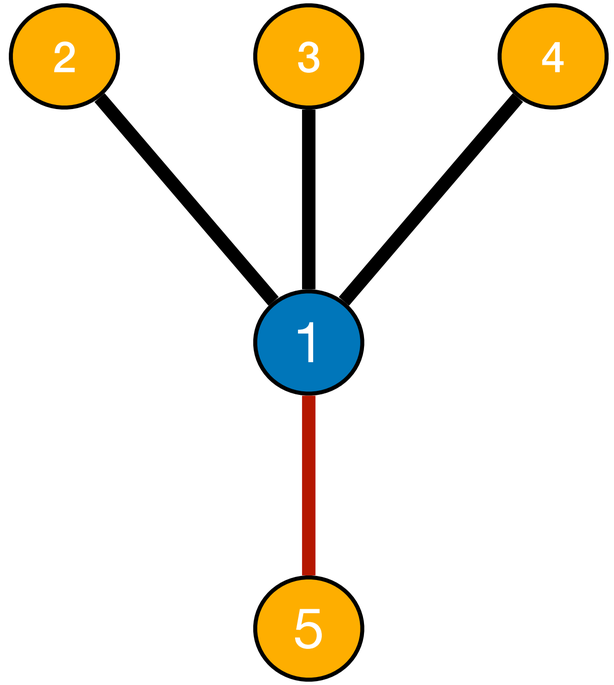
Data

- **Full-network** design - **cross-sectional** data
- Data collection: 2020 - 2021 through face-to-face questionnaire administration
- 10 villages selected because of availability of register data and small enough to ensure high respondent ratio
- Networks:
  - **Whom they talk to about health**
  - **Whom they avoid to talk to about health**
- Behaviour: **which prevention measures they adopted**
- Socio-demographic characteristics
- **ASHA** (Accredited Social Health Activist) + **traditional healer**



Complex contagion and negative influence

- Adopting outdoor preventive measures (cream) - environmental obstacles:
  - stigmatized
  - easily observable behaviour
  - small, tight community
- **Enabling mechanism**: strong **reinforcement** by **positive ties** (**threshold**-based contagion)
- **Counteracting mechanism**: adoption by **negative contacts**
- Idiosyncratic case characteristics: ‘stubborn’ and ‘zealot’ (Mobilia, 2003) agents
  - ASHA (Accredited Social Health Activist): promotes adoption
  - Traditional healer: discourages adoption



Village

Network main component

individuals (nodes) = 98

positive ties = 272

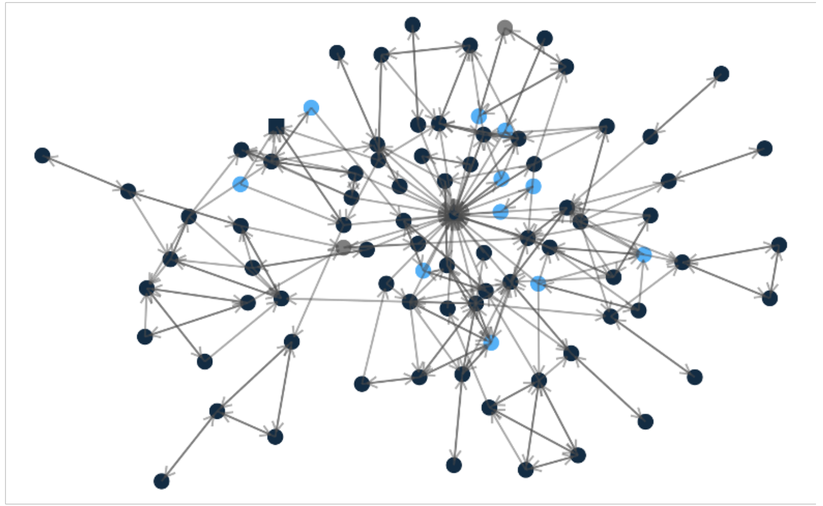
avg. degree (positive ties) = 2.78

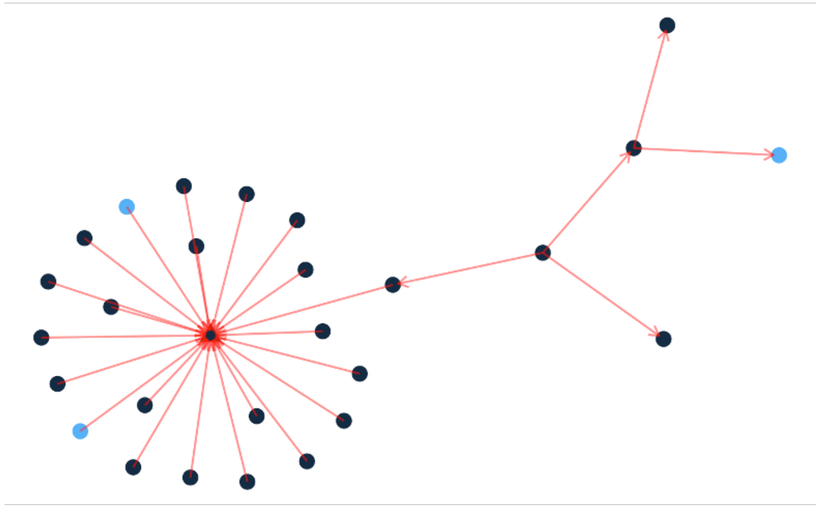
negative ties = 27

avg. degree (negative ties) = 0.28

adoption rate bednets = 95.10%

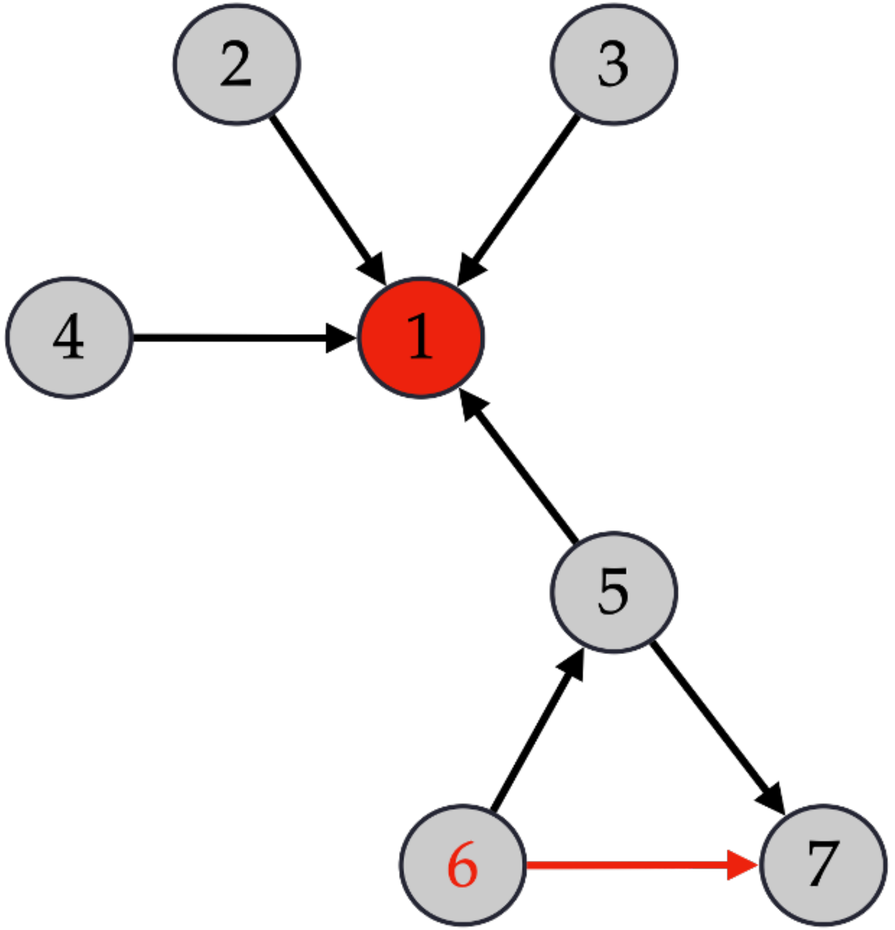
adoption rate cream = 12.75%



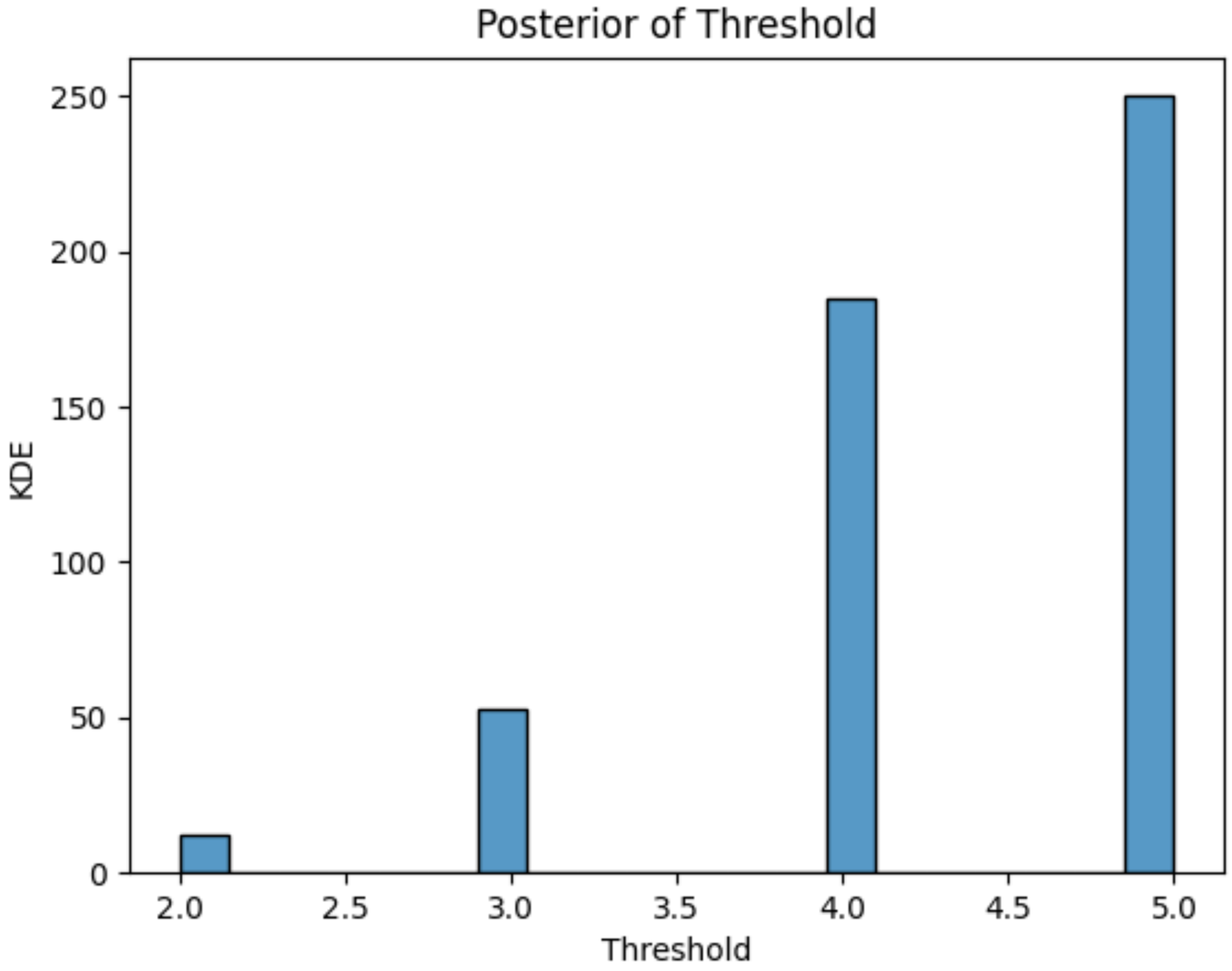


Agent-based model estimating unobserved behaviour

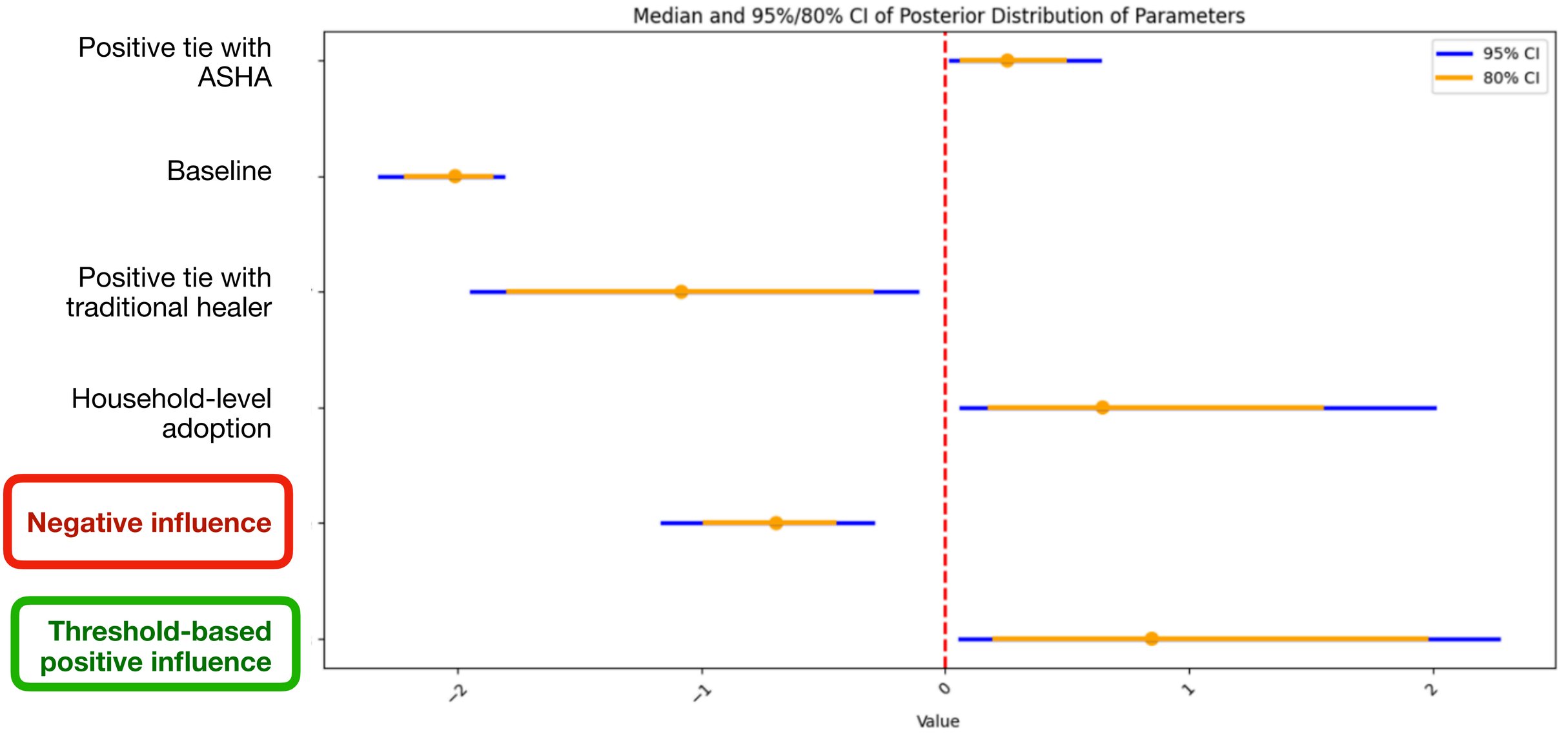
- Agent-based model (Gilbert, 2008; Squazzoni, 2012; Hedström & Manzo, 2015): computational dynamic model of the diffusion process in the empirically-observed networks (Bianchi & Renzini, *forthcoming*)
- Individuals' adoption of preventive measure as a discrete-choice (binary) model (Mc Fadden, 1978): stochastic **logistic objective function** of personal networks' composition
- **Estimating**:
  - **threshold levels** for adoption contagion
  - impact of **negative influence** (= adoption by negative contacts)
- Assuming:
  - positive impact of within-household adoption (fixed effect)
  - Positive tie with ASHA increases adoption
  - Positive tie with the traditional healer decreases adoption



Estimated threshold



Impact of positive vs. negative influence

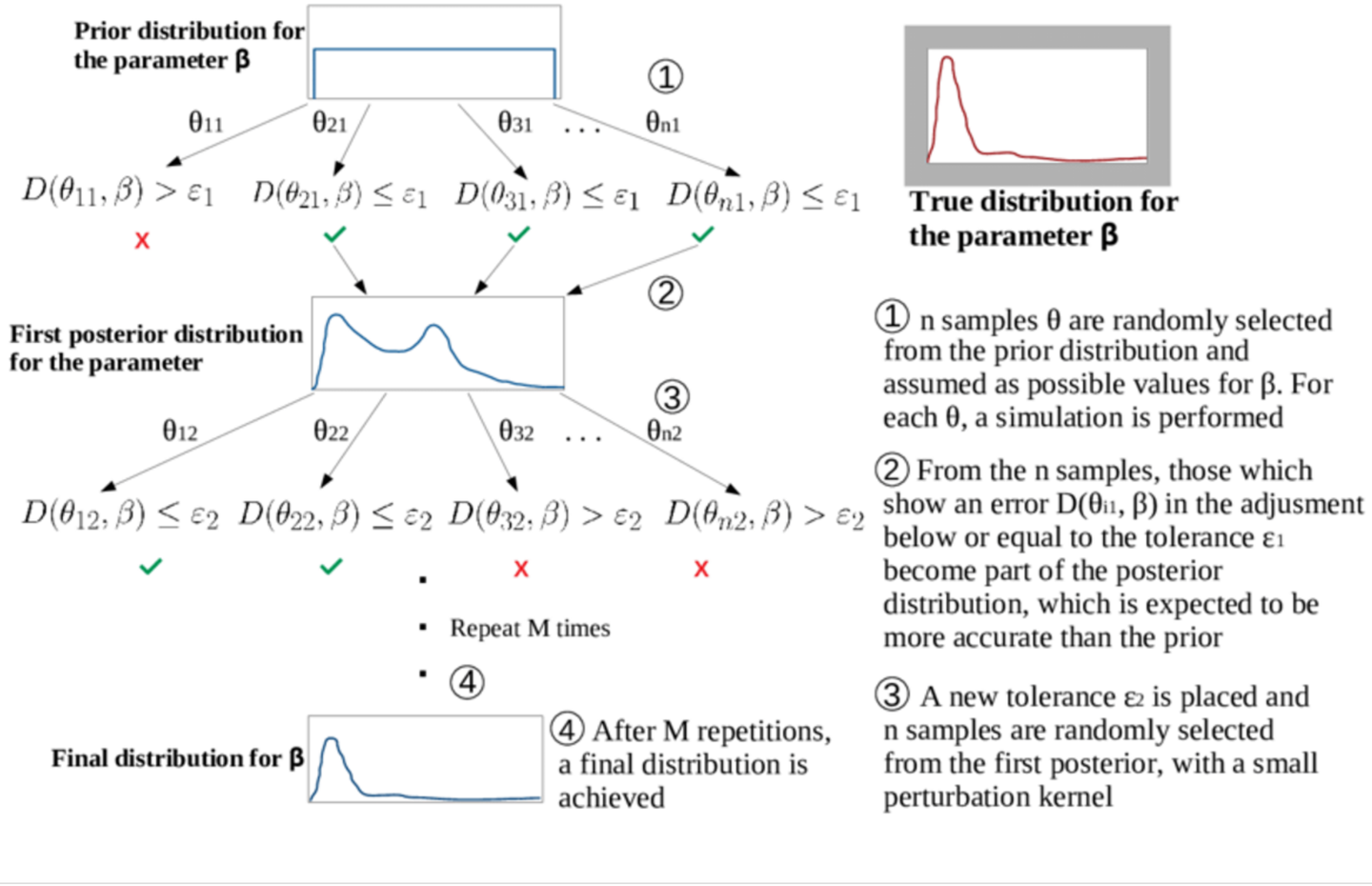


Estimation method

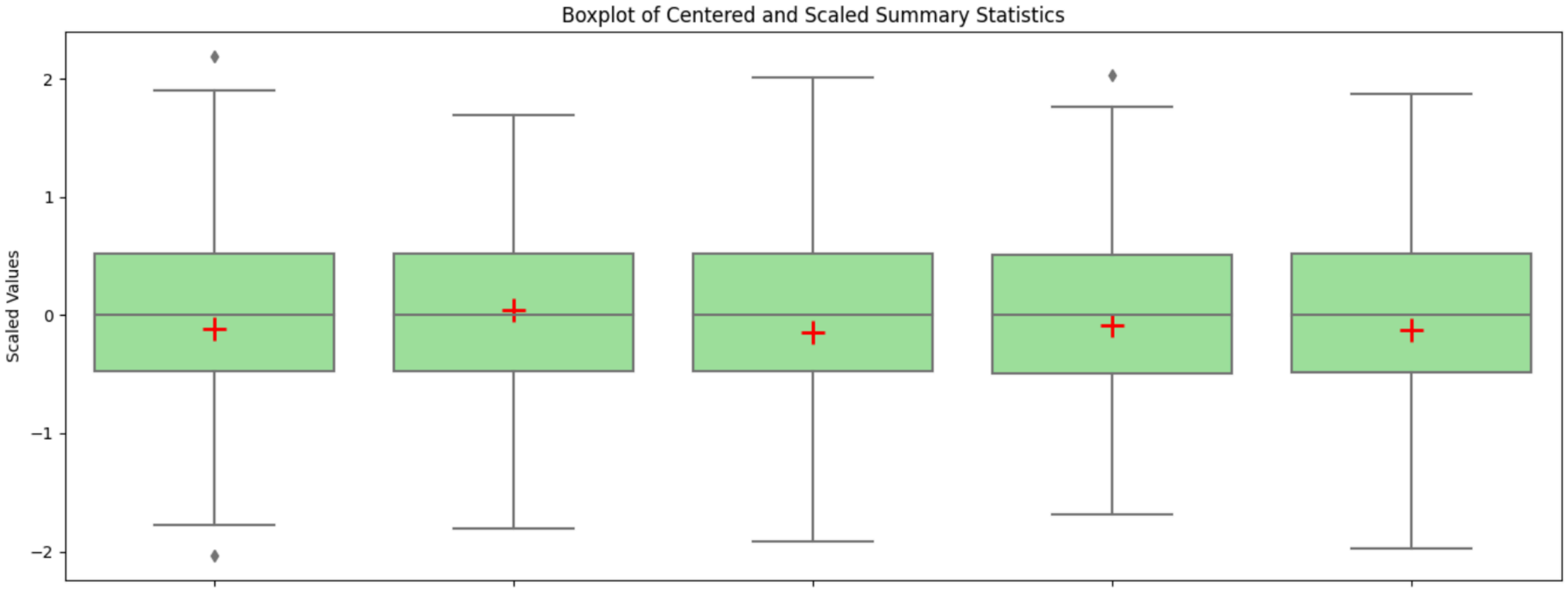
Approximate Bayesian Computation

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



Adopters' avg. degree (negative ties)	Non-adopters' avg. degree (negative ties)	Adopters' avg. degree (positive ties)	Non-adopters' avg. degree (positive ties)	Adoption rate
0.15	0.28	3.15	2.71	13.27%

Conclusions

- Diffusion of collectively beneficial, yet stigmatized behaviour might suffer from two pulling forces in one's personal network:
  - **Strong reinforcement** (high threshold levels)
  - High sensitivity to **negative influence**
- **Empirical agent-based models** can reliably estimate unobserved behaviour
- Never give up on fine-grained mechanisms if data is coarser than desired!

A large, interdisciplinary team:

Sandra Albert
Jane M. Carlton
Anne Kessler
Charishma Khongwir
Carinthia Balabet Nengnong
Quinnie Doreen Nongrum
Mattimi Passah
Rajiv Sarkar
Anna Maria van Eijk
Andras Vörös

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