

Project

The co-evolution of renewable natural resources and informal institutions, and the implications for government policy design

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The evolution of social norms for common pool resource harvesting

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Outline

- Introduction
 - Informal Institutions
 - Evolution of cooperation
- Theoretical model of a community harvesting a common pool resource
 - Choices are based on harvesting income and social consequences
- Tools
 - Individual based simulations
 - Analytical results from Adaptive Dynamics

Introduction

- Many renewable common pool resources are managed by small communities informally
 - Sometimes they are managed and preserved quite well
 - Overexploitation leads to *Tragedy of the commons*

- Successful harvesting rules may evolve
(Ostrom 1990; Baland and Platteau 1996)
- Field studies are very specific and ambiguous
 - General insights are very rare and not very specific

“The tragedy of the commons”

Garret Hardin, 1968



Fishermen in Mali, 2006



taken from the *Digital Library of the Commons*

Farmers digging drain channel in Nepal, 1993



taken from the *Digital Library of the Commons*

Firewood stand in Mozambique, 1999



taken from the *Digital Library of the Commons*

Recreational anglers in Ireland



taken from <http://galwaybayfishing.com>

Informal institutions (Social capital)

- Traditions
 - Social norms
 - Trust
 - Social status
 - Mutual agreement
 - Reputation
-
- People take these into account when making choices!
 - Our actions have social consequences

Where do these informal institutions come from?

“The extended order of human cooperation[...] arose from unintentional conforming to certain tradition and largely *moral* practices, many of which men tend to dislike, whose significance they usually fail to understand, whose validity they cannot prove, and which have nonetheless fairly rapidly spread by means of evolutionary selection”

Friedrich August Hayek, 1990 “The collected works”, vol.1, p.6

Evolution of Cooperation

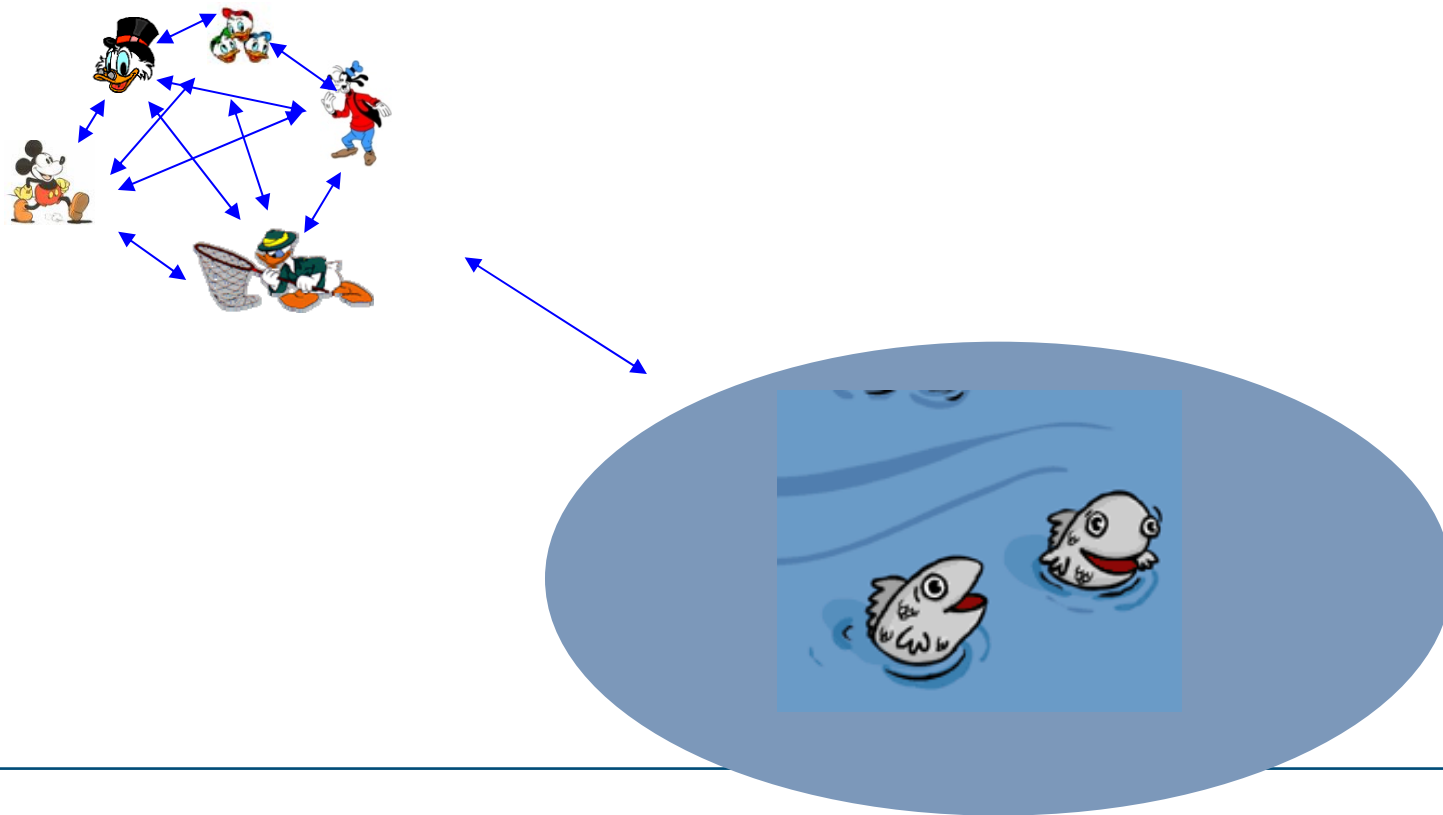
- Reputation (Nowak& Sigmund 1998, Nature)

- Punishment (Fehr& Gächter 2002, Nature)
 - Good description of the real world?
 - Breaking of social ties (Van Soest and Vyrastekova 2004)
 - Social disapproval
 - Is this costly?
 - 2nd order public good
 - Some agents have social preferences or internal sense of duty

Research questions

- When do social norms evolve?
- Why are most social norms beneficial?
 - One explanation: Group selection
 - (Boyd and Richerson, 2005, *Not by genes alone*)
 - (Gurerk et al. 2006 Science)
 - Is this the only explanation?
- What about the stability of social norms?

Informal institutions co-evolve with the environment



When are the individuals happy?

- When they make a lot of money from harvesting
- When their behavior is appreciated by the rest of the community



The model in a nutshell

- In this system the exploitation level co-evolves with social appreciation for modest/greedy/lazy agents
- Every agent holds a continuous trait for social (dis)approval of non-conformity
- Utility depends on income from harvesting a resource and social consequences.
- Imitation and trial-and-error create evolutionary dynamics

Is social (dis)approval costly?

- Talk is cheap
- It may be implicitly costly
 - Stressful, as it may causes trouble
 - Disapprovees may refuse to cooperate in the future
 - Makes one vulnerable to own moral defection
 - May require a certain commitment
- Essentially an empirical question
 - Evidence ambiguous

Dynamic system

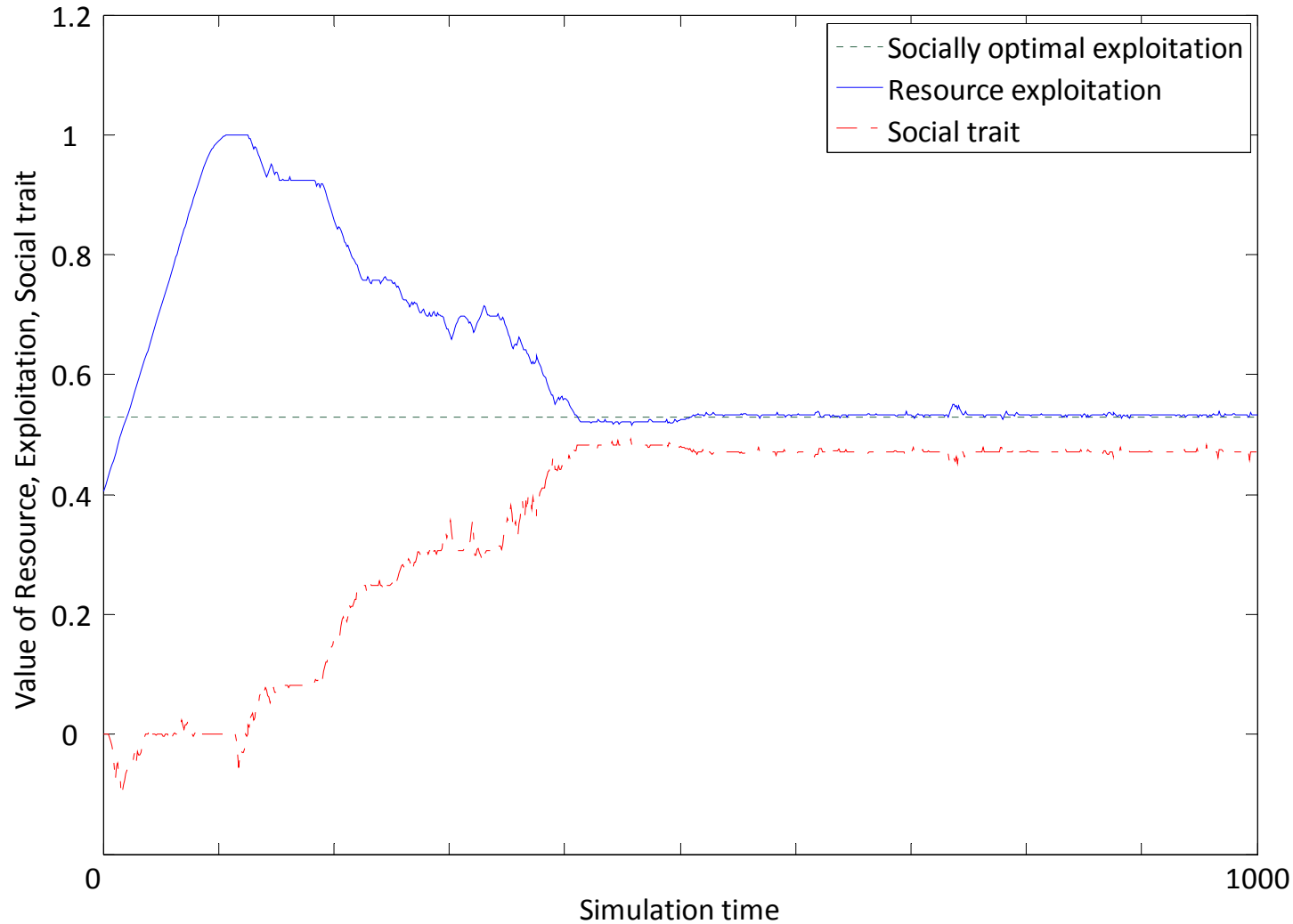
- Resource dynamics
 - quick
- Change in exploitation strategy
 - Slow
- Social trait
 - Very slow

Agent based simulations

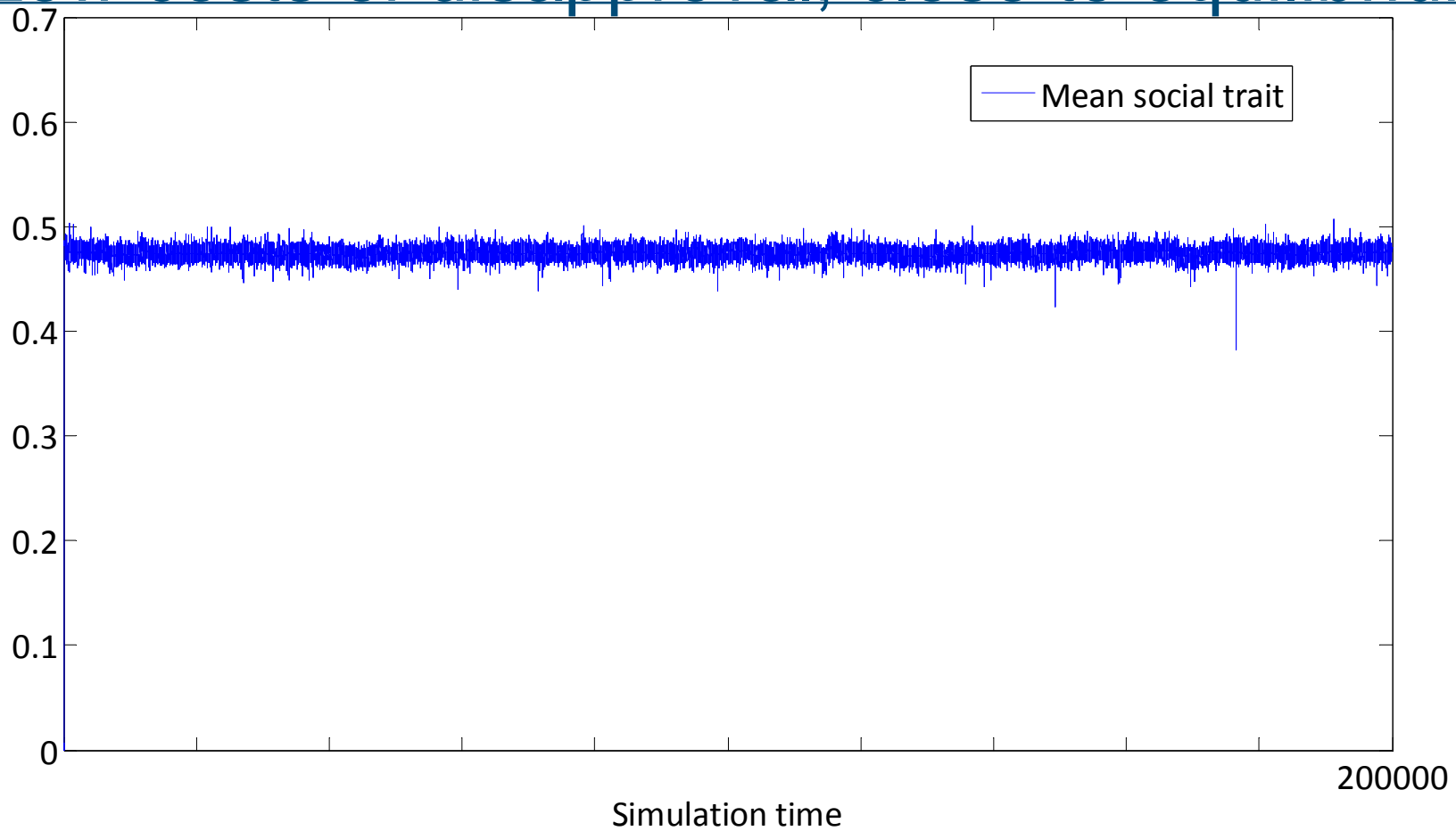
Results

- The social trait may evolve towards a level that maximizes community welfare
 - This depends highly on
 - The time the system gets to equilibrate (Strength of the feedbacks)
 - The costs of social disapproval

Low costs of disapproval, close to equilibrium

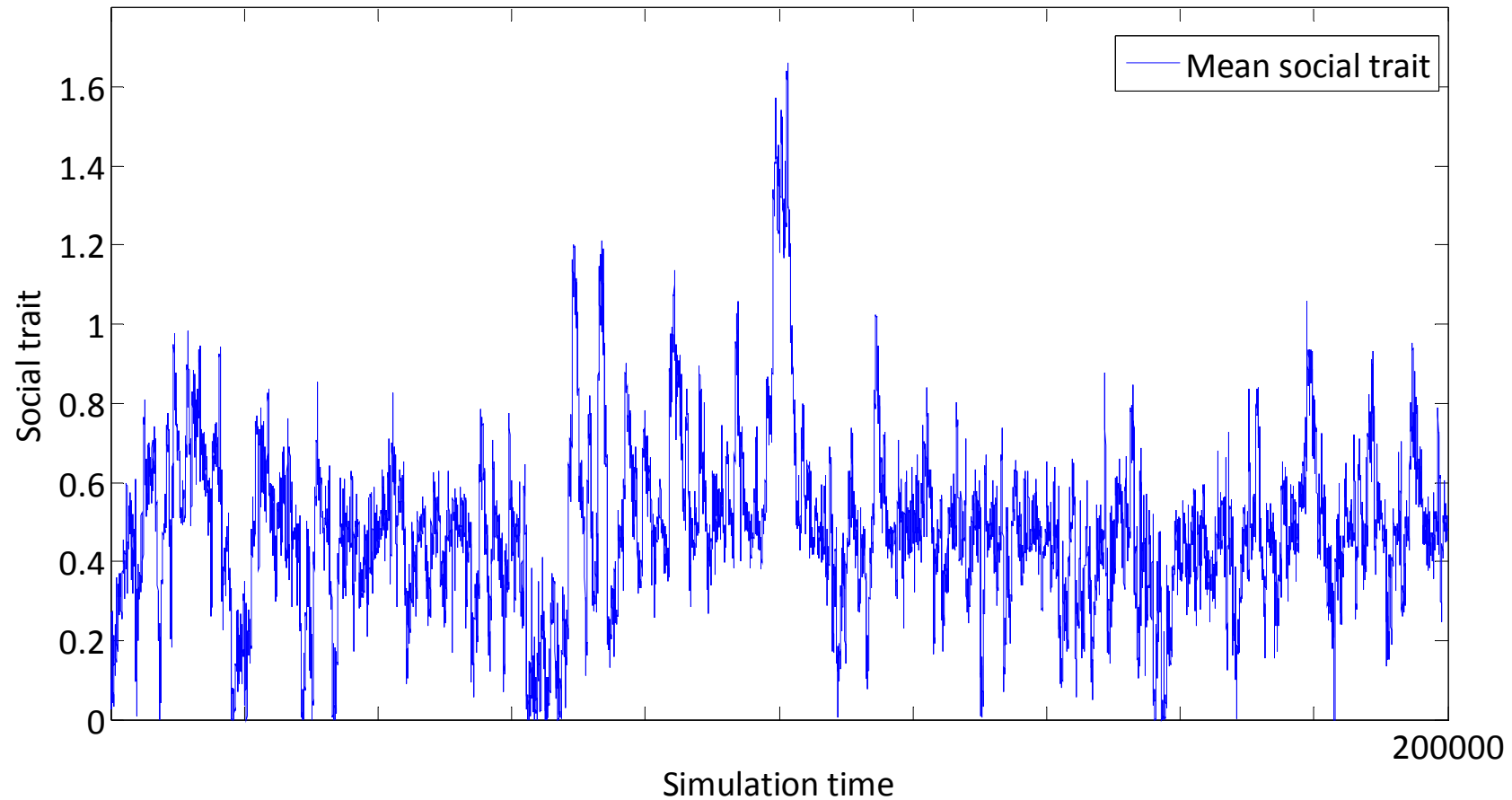


Low costs of disapproval, close to equilibrium



Mean exploitation simulation: 0.4765
Optimal exploitation: 0.4762

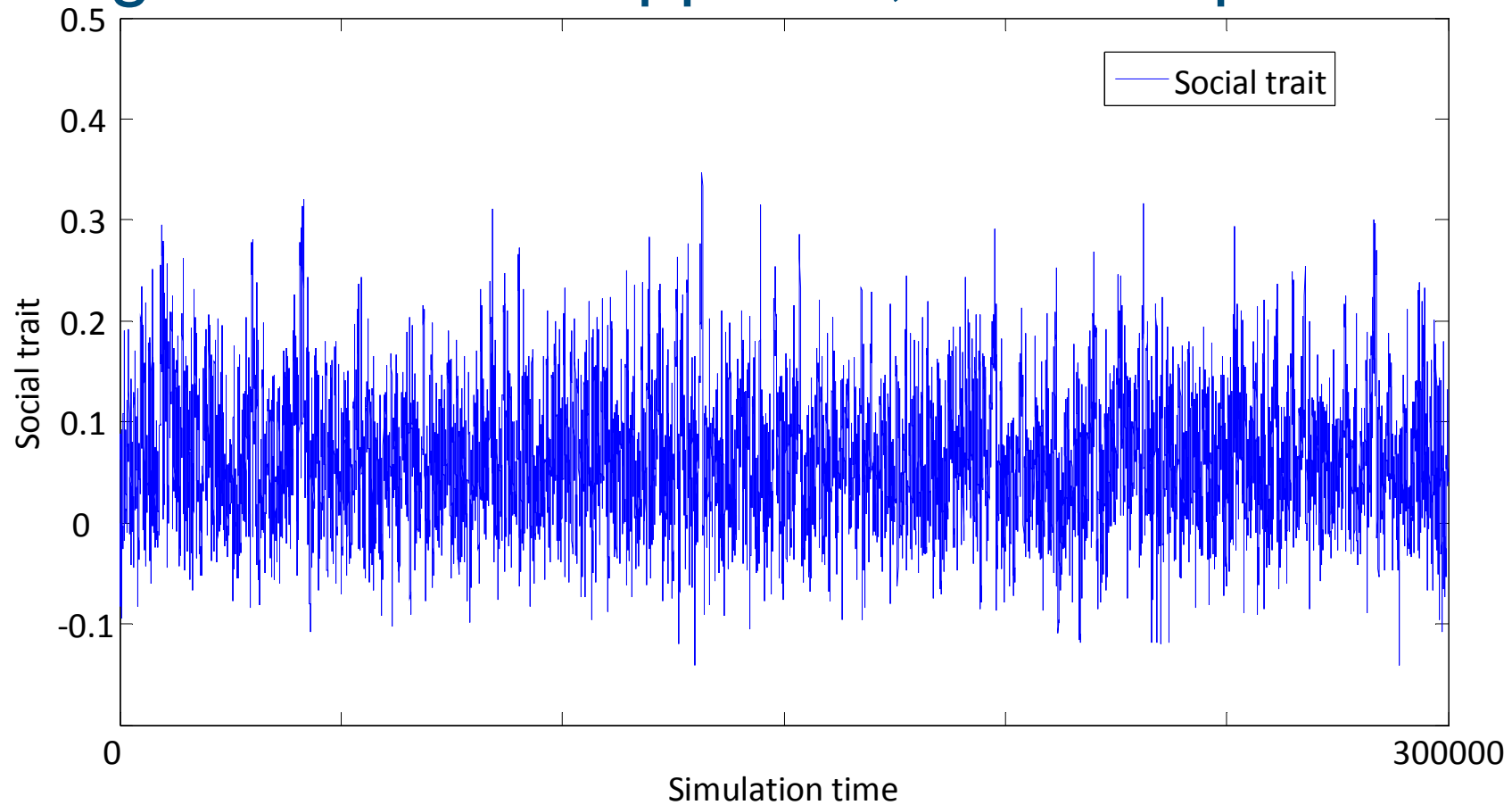
No costs of disapproval, far off equilibrium



Mean exploitation simulation: 0.4778

Optimal exploitation: 0.4762

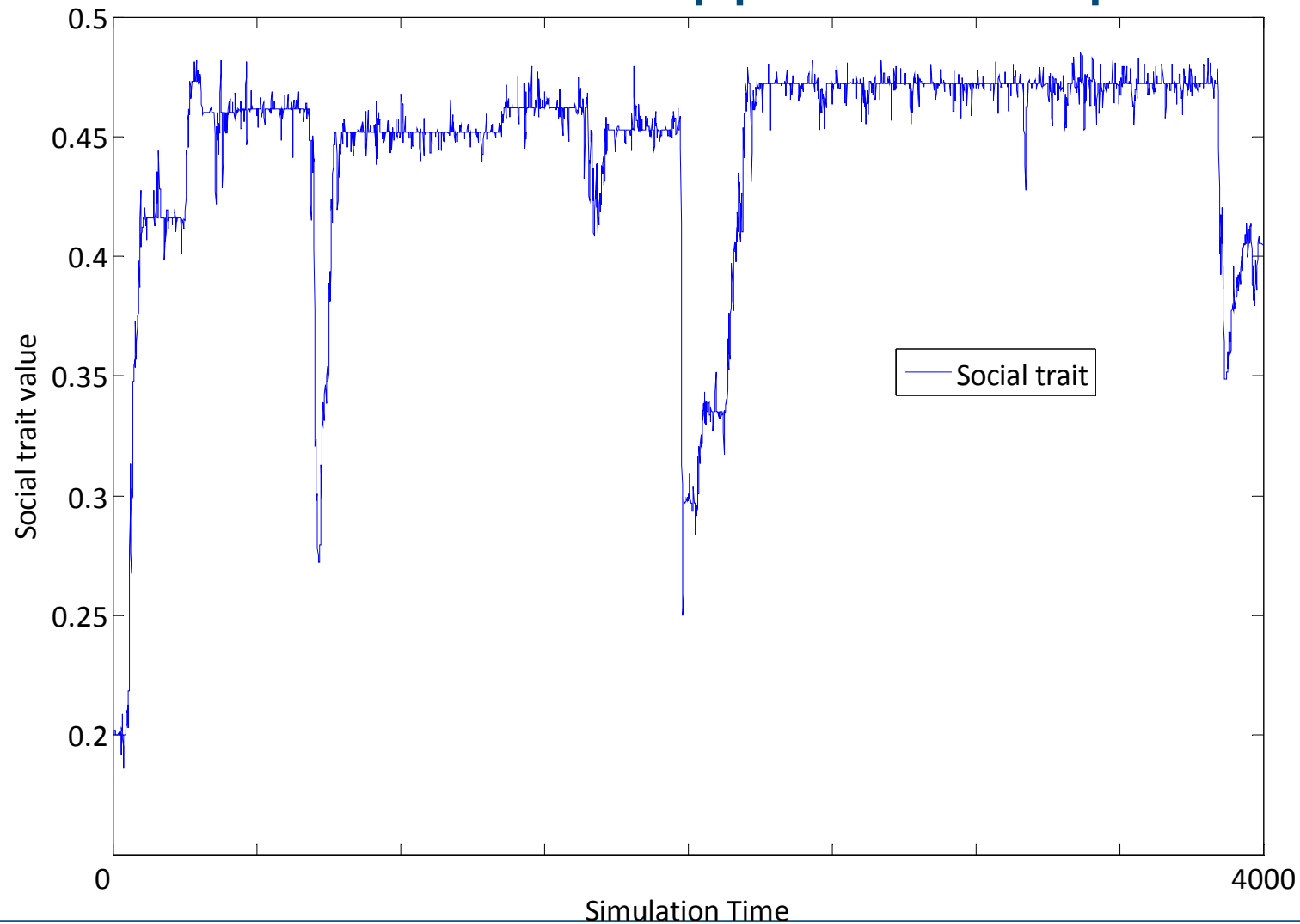
High costs of disapproval, far off equilibrium



Mean exploitation simulation: 0.67

Mean social trait simulation: 0.047

Medium costs of disapproval & equilibrium

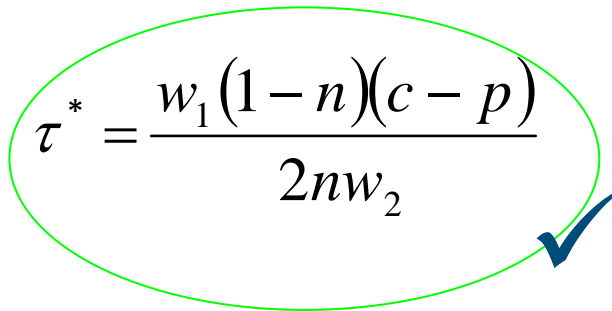


Adaptive Dynamics

- Continuous traits
 - Mutations
 - Links population dynamics to evolutionary dynamics
 - Very useful for modeling co-evolution
 - Processes operate at different time scales
 - Community is in equilibrium when a mutation occurs
 - If the new strategy is more successful, it replaces the old one
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- Differential equation that shows trait change over time:
 - Canonical equation of Adaptive Dynamics
(Dieckmann & Law 1996)
 - Geometrical tool:
 - Pairwise invasibility plots (Geritz et al. 1998)
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Analytical solution

- The corresponding equilibrium is

$$\tau^* = \frac{w_1(1-n)(c-p)}{2nw_2}$$


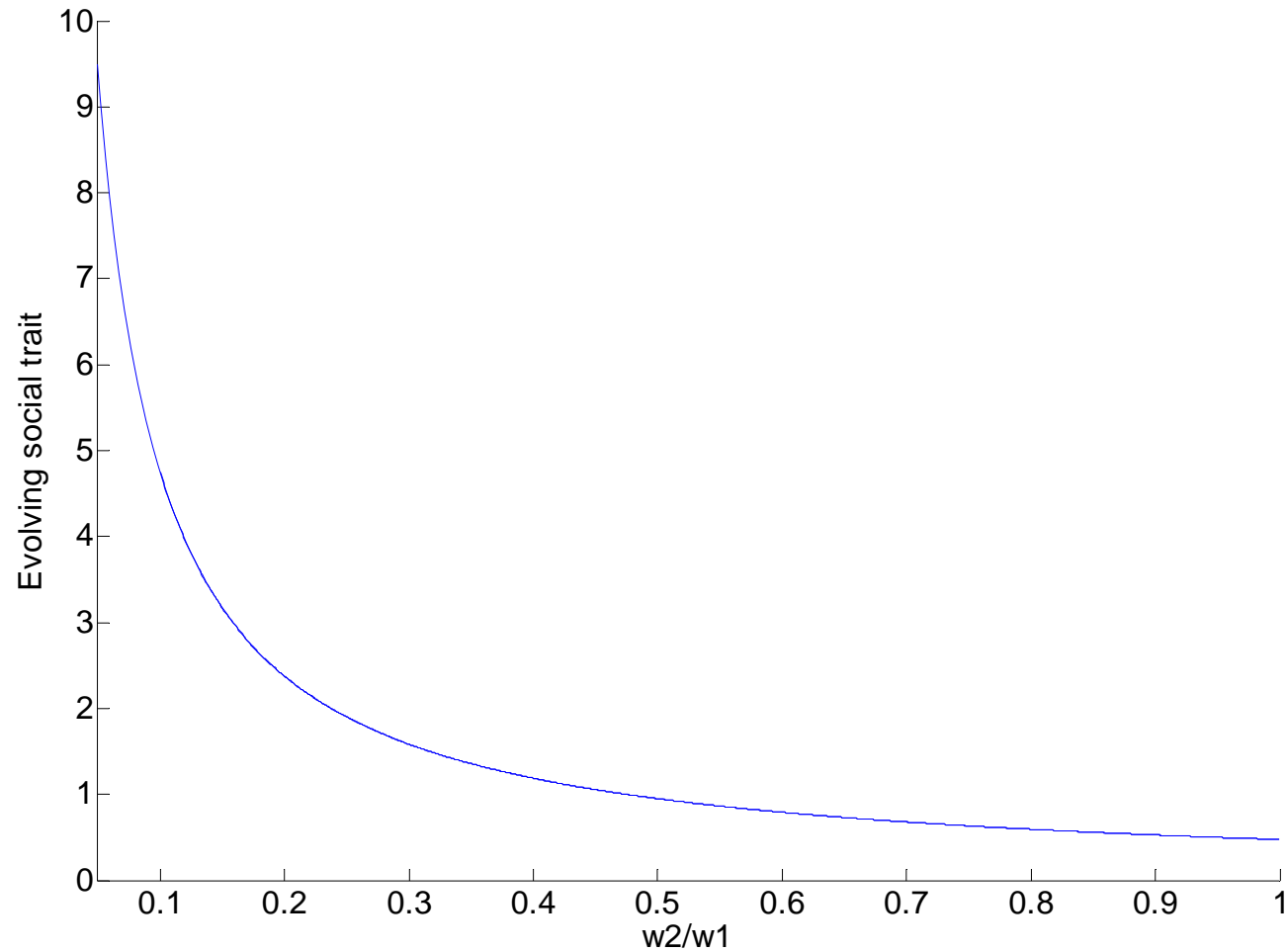
It is a fitness maximum, hence evolutionary stable

It can be attained, hence convergent stable

Yes, this is an evolutionary attractor

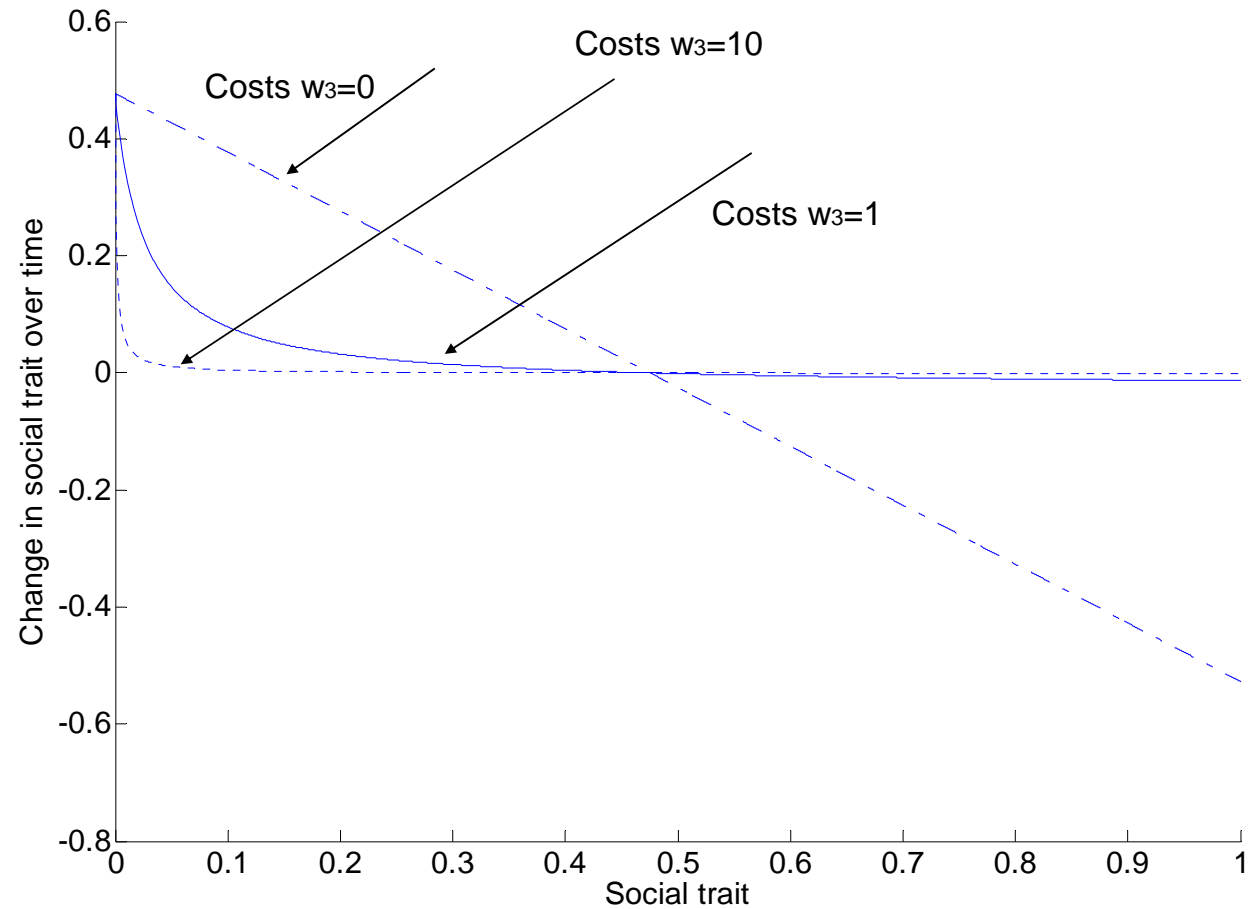
- This trait value leads to optimal exploitation!
- Its value depend on
 - The importance of money vs. social status
 - The size of the community
 - Costs of exploitation, market price of the resource
 - It does not depend on the costs of (dis)approval

What is the role of the different weights in the utility function?

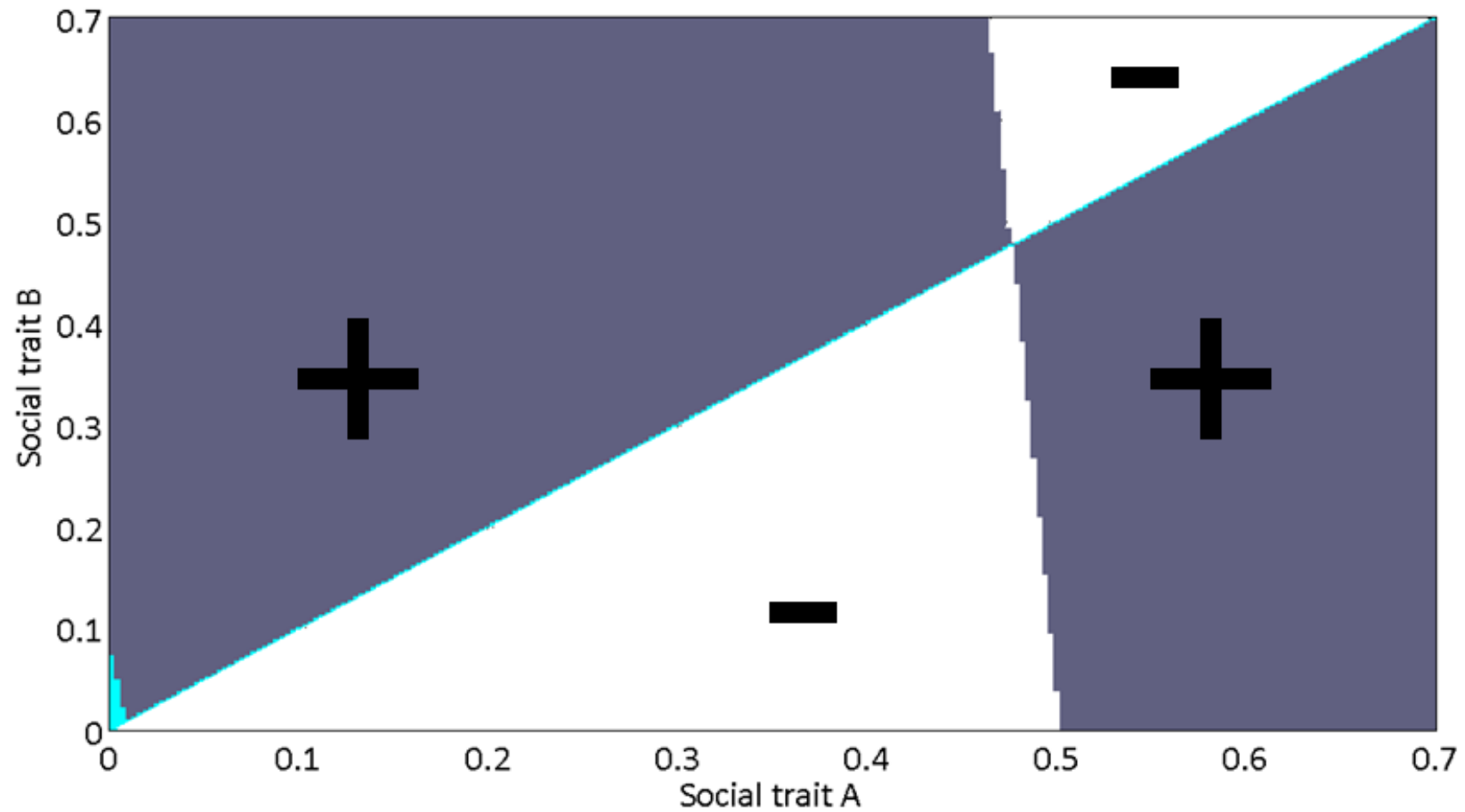


Costs of disapproval

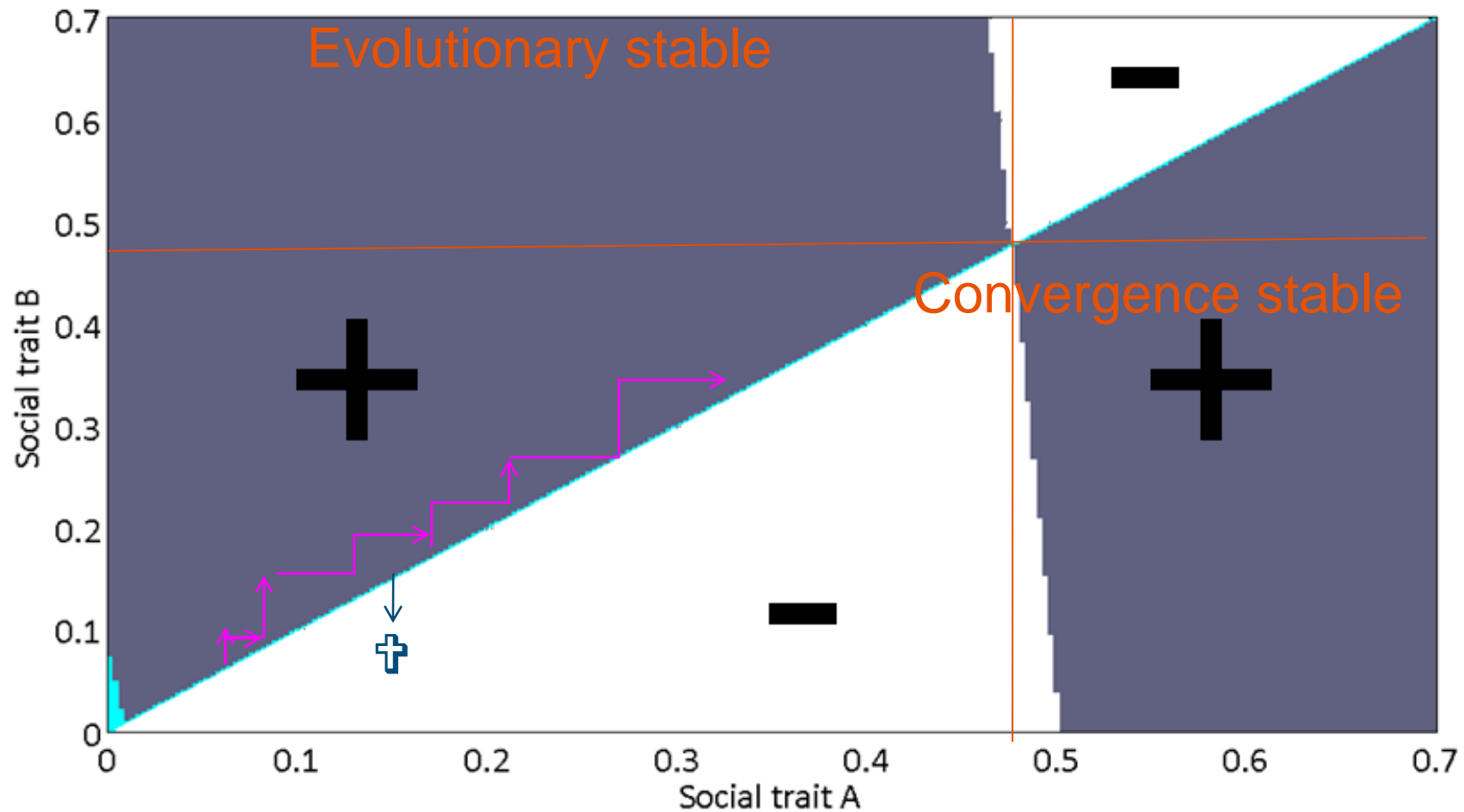
- When costs are high, the evolutionary attractor may be drowned in noise!



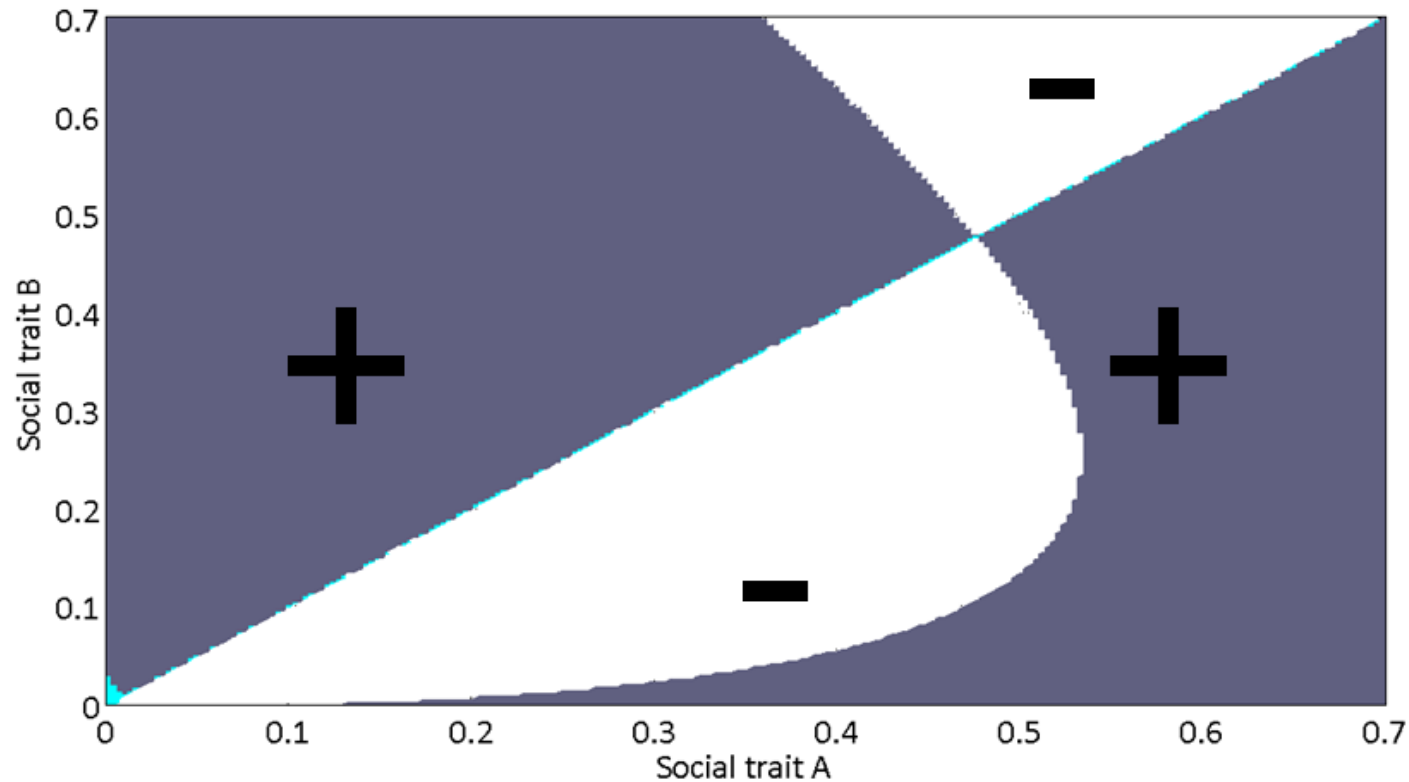
Pairwise invasibility plot



No costs, 1 out of 20 agents holds trait B



High costs, 5 agents hold trait B



Suddenly low social trait values can invade.
This is why we observe these collapses!

Results

- When feedbacks from the resource are strong and agents respond to social pressure by adjusting their behavior, a social norm will evolve that maximizes community welfare
- High costs of disapproval can be a serious obstacle for the establishment of such a norms
- If a sufficient number of agents hold by mistake a low social trait that delivers low utility, this low trait becomes superior, leading to a sudden collapse of the old norm

Further research

- What happens when the feedback from the resource is very slow?
- Non-linear resource dynamics
 - Agents learn to interpret an early warning signal
- Allow the evolution of a function valued trait of social (dis)approval that may produce
 - Asymmetric punishment and reward
 - Strict or lenient (dis)approval
 - Severe or soft (dis)approval
- Is this related to observability of actions/ utility ?

Putting things into perspective

- Success stories occur easier in small ecosystems, than in big ones



In larger ecosystems social norms do exist as well, but they are very different

Any restriction of their ability to land as many fish as they could was at loggerheads with the deep-seated core value of the fishing game: the fisherman's desire to catch more than his neighbours.

Rob van Ginkel (forthcoming, *Braving Troubled Waters: Sea Change in a Dutch Fishing Community*)

The answer of one skipper, when asked about the profitability of a recent investment made to improve the catching capacity of the trawl, illustrates this rationale:

"It is not a question of cost, but of fishing more than your neighbour. And that is usually good business."

Stig S. Gezelius (2007, *The Social Aspects of Fishing Effort. Technology and Community in Norway's Blue Whiting Fisheries*)