Five Shades of Green

Heterogeneous Environmental Attitudes in an Evolutionary Game Model

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Background

Behavioural aspects of interactions

- Peer effects (Collier, 2016)
- Punishment (Boyd and Richerson, 1991)
  - And second-order punishment
- Outsider Vs Insider identities (Akerlof, 2010)
  - ➢ *Heterogeneous agents' attitudes*
- Elitist preferences (Antoci et al., 2018)

Background

Previous attempts at a taxonomy of environmental behaviours

- Normative, Hedonic, and Gain motives (Lindenberg and Steg, 2007)
  - ➢ Gkargkavouzi et al. (2019) on constraints
  - ➢ Geng et al. (2017) on travel behaviour
  - ➢ Steg et al. (2014) on strengthening normative motives

We provide game-theoretic foundations to environmental behaviours and analyse the interaction in heterogeneous populations.

Research Question

How does heterogeneity of behaviours impact the diffusion of environmental social norms?

The Model

We introduce five types of agents, with different preferences order:

i. *Ecologist*
ii. *Non-Ecologist*
iii. *Schizofrenic Ecologist*
iv. *Ashamed Non Ecologist*
v. *Snob Ecologist*

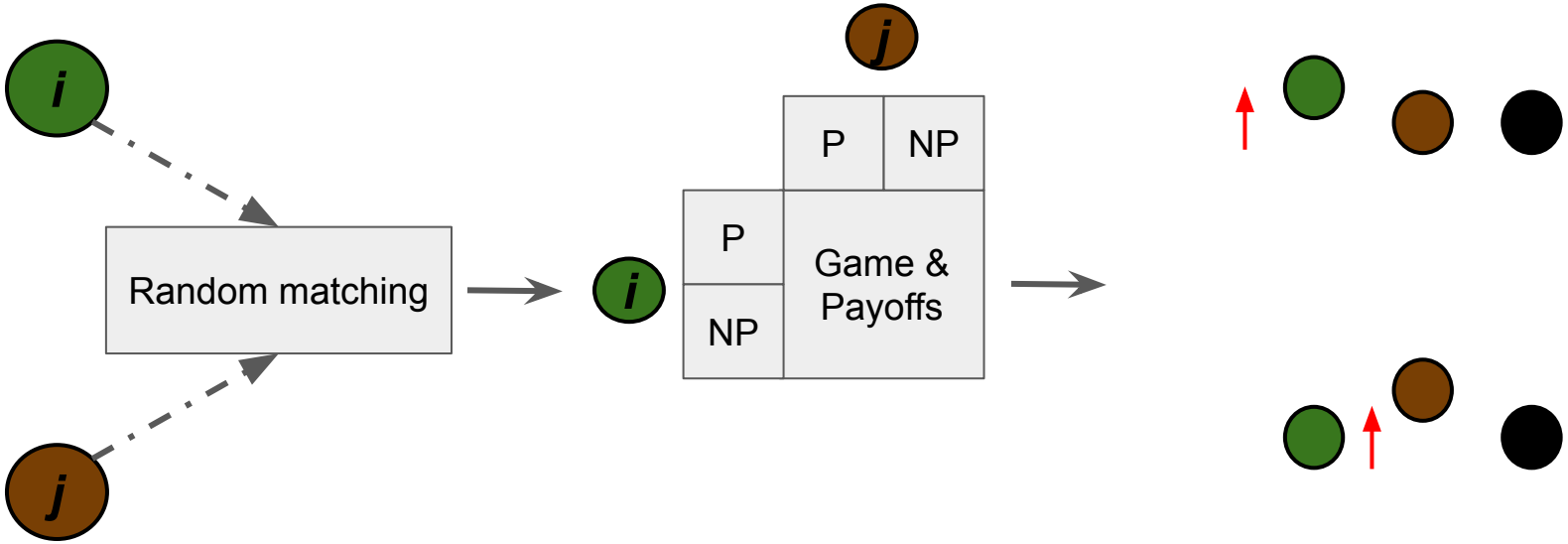
The Model

- Agents are pairwise matched and choose whether to Pollute ***(P)*** or Not Pollute ***(NP)***.

- Every agent chooses between ***P*** and ***NP*** according to the agents she faces

- We analyse triplets of types in an evolutionary model
  - Diffusion of one type depends on its relative payoff
  - Three population scenarios studied

The Model



The Model

The Ecologist (E)

Always follows the environmental social norm, irrespective of others' behaviour:

$$(NP, NP) \succ (NP, P) \succ (P, NP) \succ (P, P)$$

The Model

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Always follows the environmental social norm, irrespective of others' behaviour:

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The Model

The Non-Ecologist (NE)

Always disregards the environmental social norm, irrespective of others' behaviour:

$$(P, NP) \succ (P, P) \succ (NP, NP) \succ (NP, P)$$

The Model

The Non-Ecologist (NE)

Always disregards the environmental social norm, irrespective of others' behaviour:

$$(P, NP) \succ (P, P)$$

The Model

The Schizofrenic Ecologist (SE)

Prefers to follow environmental social norm, but hates to be the only one to do so:

$$(NP, NP) \succ (P, NP) \succ (P, P) \succ (NP, P)$$

The Model

The Schizofrenic Ecologist (SE)

Prefers to follow environmental social norm, but hates to be the only one to do so:

$$(NP, NP) \succ (P, P)$$

The Model

The Ashamed Non-Ecologist (ANE)

Would prefer not to follow environmental social norm, but feels ashamed in being the only one not to:

$$(P, P) \succ (NP, NP) \succ (NP, P) \succ (P, NP)$$

The Model

The Ashamed Non-Ecologist (ANE)

Would prefer not to follow environmental social norm, but feels ashamed in being the only one not to:

$$(P, P) \succ (NP, NP)$$

The Model

The Snob Ecologist (SnE)

Prefers being the only one following the environmental social norm, always respects it anyways:

$$(NP, P) \succ (NP, NP) \succ (P, NP) \succ (P, P)$$

The Model

The Snob Ecologist (SnE)

Prefers being the only one following the environmental social norm, always respects it anyways:

$$(NP, P) \succ (NP, NP)$$

The Model

Replicator Dynamics

“The best performing strategy should diffuse faster”

“The last few take longer to change mind”

The diffusion of type ***i*** depends on its relative payoff:

$$\dot{x_i} = x_i(e_i \cdot Ax - x \cdot Ax)$$

(Taylor and Jonker, 1978

Bjoernerstedt and Weibull, 1994

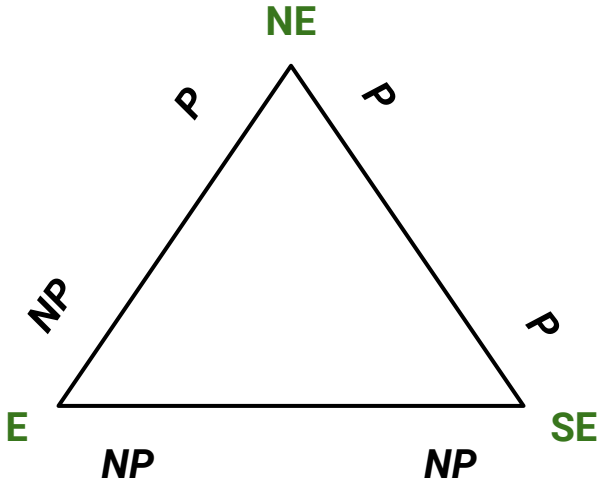
Weibull, 1995)

The Model

- Three population scenarios:
  - Benchmark - ***E***, ***NE***, ***SE***
  - Identity - ***SnE***, ***NE***, ***SE***
  - Social Norm - ***E***, ***NE***, ***ANE***

Benchmark scenario: E, NE, SE

How do the agent types behave in this population?



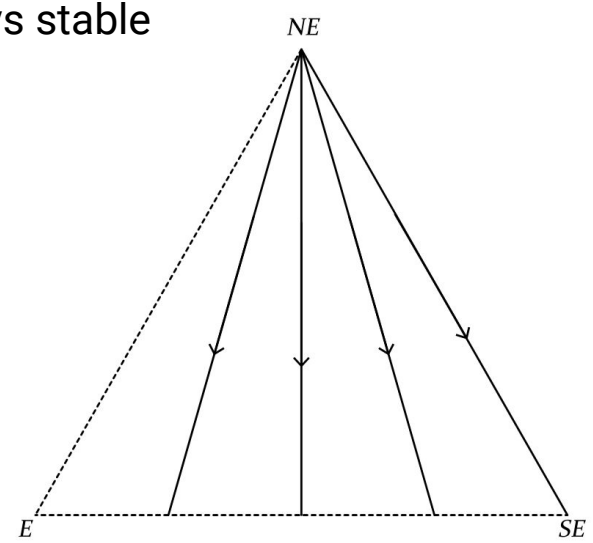
	E	SE	NE
E	1	1	α
SE	1	1	β
NE	1	γ	γ

$0 < \alpha, \beta, \gamma < 1$

Benchmark scenario: E, NE, SE

Results:

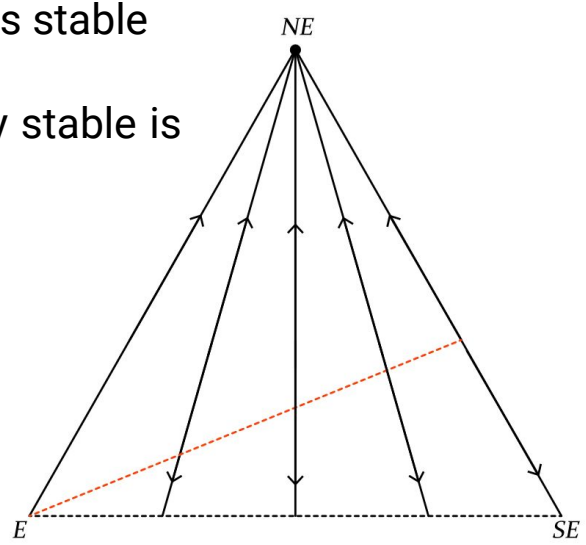
- Pointwise stationary states on lower edge are always stable



Benchmark scenario: E, NE, SE

Results:

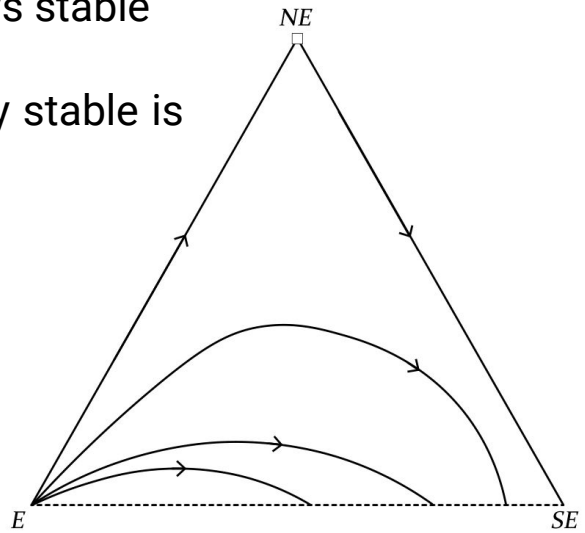
- Pointwise stationary states on lower edge are always stable
- The only stationary state that can be asymptotically stable is the one where all agents are ***NE***



Benchmark scenario: E, NE, SE

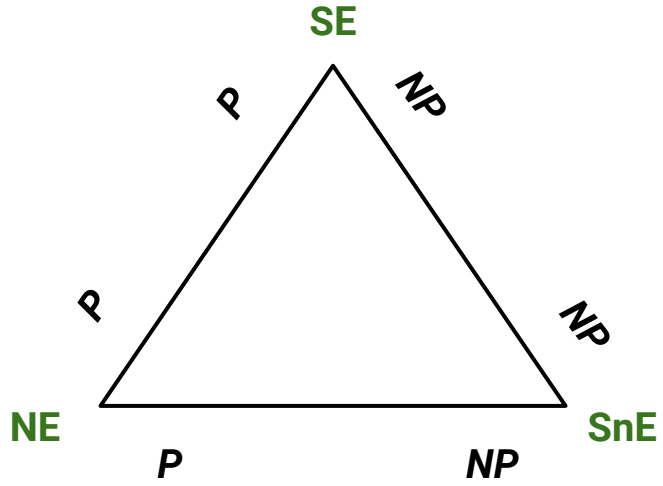
Results:

- Pointwise stationary states on lower edge are always stable
- The only stationary state that can be asymptotically stable is the one where all agents are ***NE***
- No stable internal stationary state



Identity scenario: SnE, NE, SE

How do the agent types behave in this population?



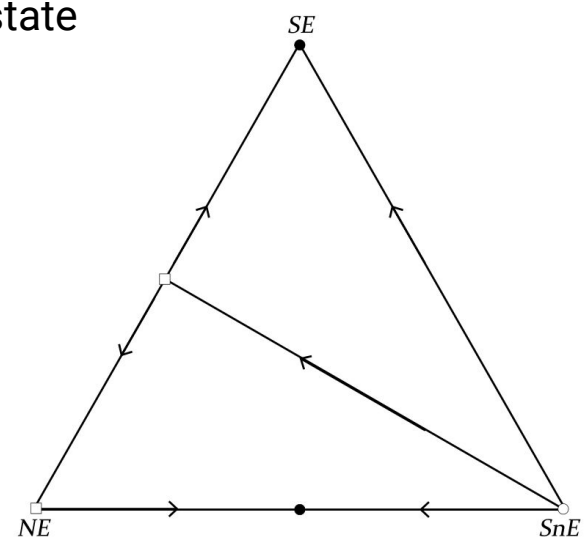
	NE	SnE	SE
NE	α	1	α
SnE	1	β	β
SE	γ	1	1

$0 < \alpha, \beta, \gamma < 1$

Identity scenario: SnE, NE, SE

Results:

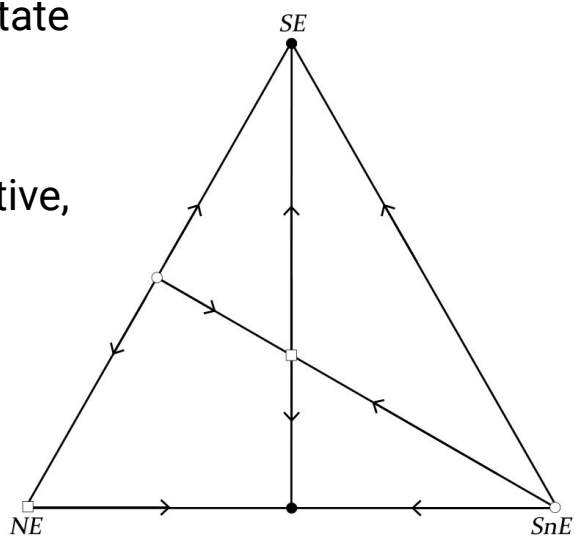
- The unique pure population attractive stationary state is the one in which all agents are ***SE***



Identity scenario: SnE, NE, SE

Results:

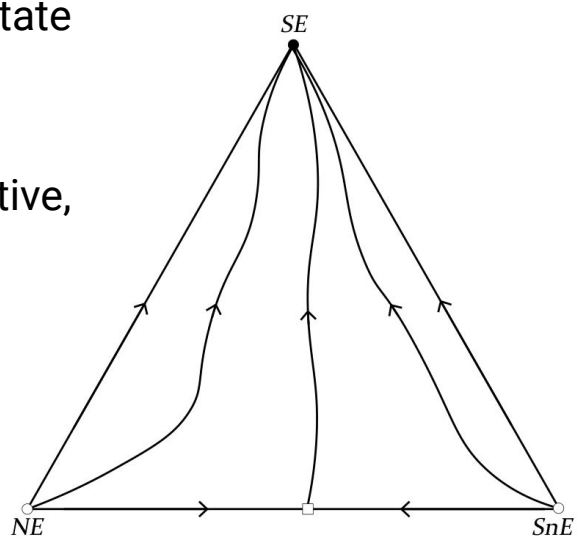
- The unique pure population attractive stationary state is the one in which all agents are ***SE***
- A mixed population stationary state can be attractive, where ***NE*** and ***SnE*** coexist



Identity scenario: SnE, NE, SE

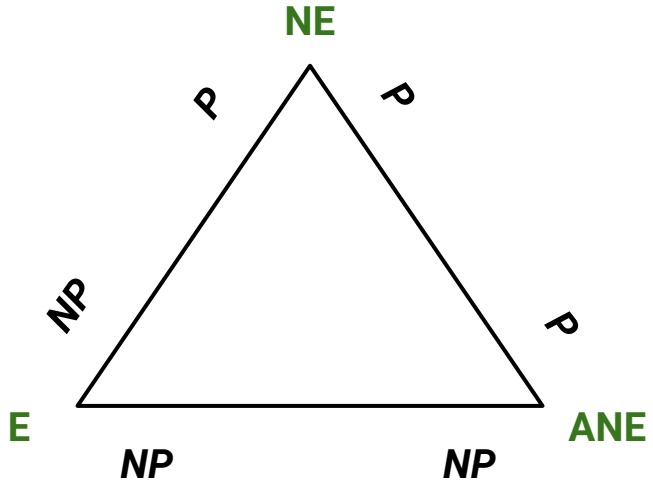
Results:

- The unique pure population attractive stationary state is the one in which all agents are ***SE***
- A mixed population stationary state can be attractive, where ***NE*** and ***SnE*** coexist
- No stable internal stationary state



Social Norm scenario: E, NE, ANE

How do the agent types behave in this population?



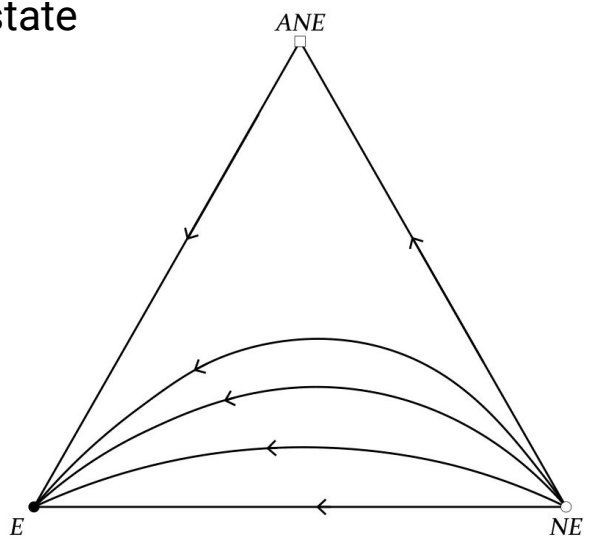
	E	NE	ANE
E	1	α	1
NE	1	β	β
ANE	γ	1	1

$0 < \alpha, \beta, \gamma < 1$

Social Norm scenario: E, NE, ANE

Results:

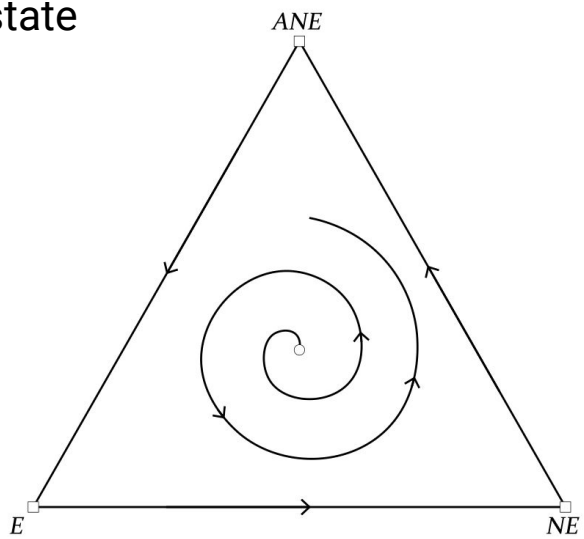
- The unique pure population attractive stationary state is the one in which all agents are ***E***



Social Norm scenario: E, NE, ANE

Results:

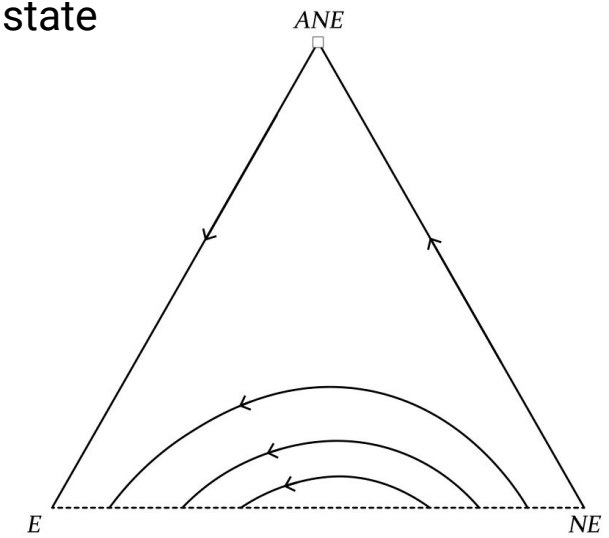
- The unique pure population attractive stationary state is the one in which all agents are ***E***
- A hypercycle may arise



Social Norm scenario: E, NE, ANE

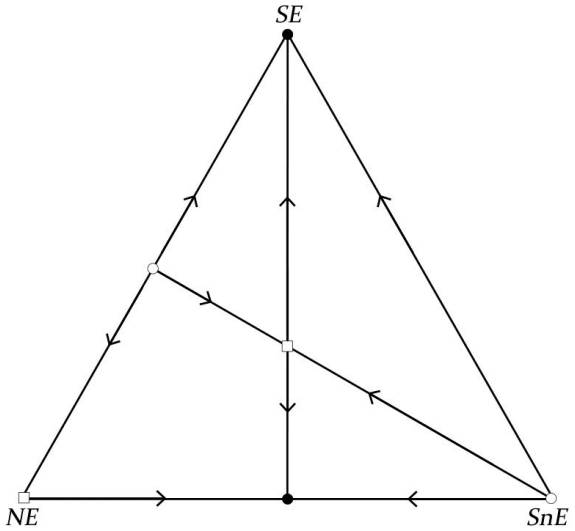
Results:

- The unique pure population attractive stationary state is the one in which all agents are ***E***
- A hypercycle may arise
- No stable internal stationary state



Conclusions

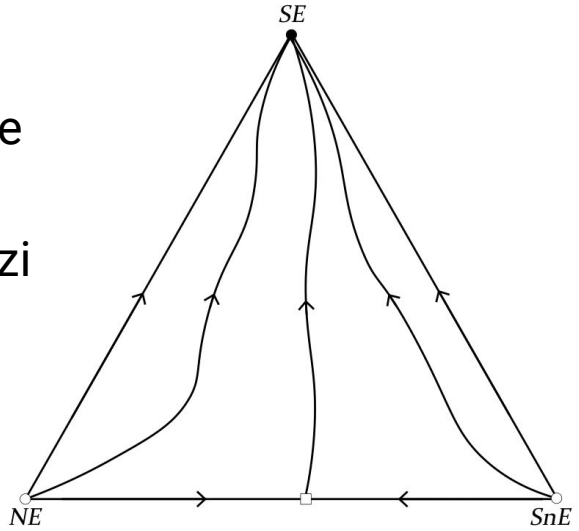
- ✓ The analysed behaviours cannot coexist all together.
- ✓ Importance of initial distribution!



Conclusions

✓ *SnE* types may favour the emergence of virtuous behaviour, whereas hardcore *Ecologists* may be unable to do so.

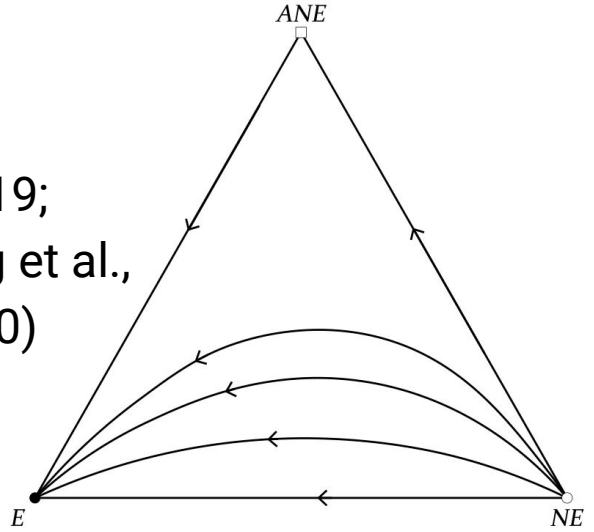
➢ *Elitist* preferences make virtuous behaviours more resistant to egotistic behaviours (Gkargkavouzi et al., 2019; Moore and Boldero, 2017)



Conclusions

✓ *ANE* types behave just as *SE* types, but the former favours diffusion of *Ecologists* while the latter favours the *NE* instead!

➢ Social norm works better than punishment! (Gkargkavouzi et al., 2019; Steg et al., 2014; Nyborg et al., 2006; Cialdini et al., 1990)



Thank you for your attention.