Modelling maladaptation in the inequality-environment nexus

Elisa Ticci

University of Siena

Coauthors: Angelo Antoci and Paolo Russu

University of Sassari

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Literature on the inequality – environment nexus

Does environmental degradation and pollution exacerbate inequalities? Yes

Channels of transmission

- Exposure: The poor are often more exposed than the rich
- Vulnerability: The poor are less able to cope with and to adapt to environmental degradation than the rich

Does inequality harm the environment? It depends.

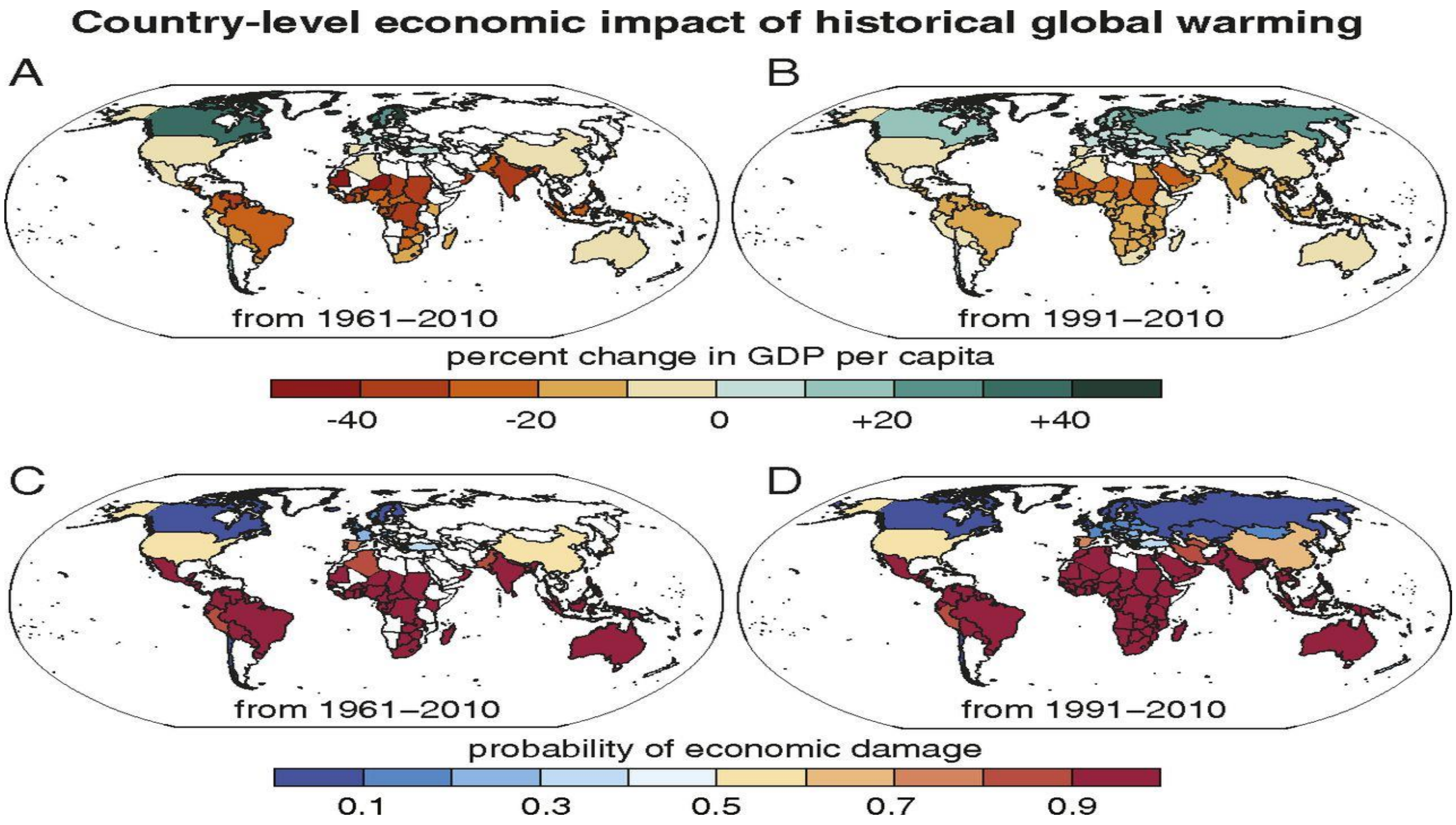
Channels of transmission:

- technological progress
- consumers' preferences for pollution intensive goods
- social groups' political demands for environmental quality

The relation can change in relation to:

- ✓ Degree of industrialization (Gassebner et al. 2008)
- ✓ Income level (Grunewald et al. 2017),
- ✓ Trade regime (McAusland 2003)
- ✓ Political regime/democracy (Kashwan 2017)
- ✓ Types of environmental impact: local/global (Heerink et al. 2001, Clement and Meunie, 2010)

Country-level economic response to global warming.



Noah S. Diffenbaugh, and Marshall Burke, 2019, **Global warming has increased global economic inequality**. , PNAS, doi:10.1073/pnas.1816020116

Channels of interaction *in* and *out* of the model

Included

- *In line with earlier literature*: Different coping ability between the rich and the poor: **environmental degradation → inequality**
- *The novelty of our model*: **maladaptation**. Defensive strategies may offer a first shelter while at the same time creating environmental externalities

Excluded / not considered

- Income effect on policy demand, technology and consumers' preferences
- No structural change

The key question: in this context,
high (low) inequality → high (low) environmental quality?

It’s maladaptation. Is it a big deal?

IPCC 2001: Poor adaptation or “maladaptation” also may lead to increased impacts and vulnerability in the future”,

IPCC 2014: **“**poor planning or implementation, overemphasizing short-term outcomes or failing to sufficiently anticipate consequences can result in **maladaptation**, increasing the vulnerability or exposure of the target group in the future or the vulnerability of other people, places or sectors (medium evidence, high agreement). Underestimating the complexity of adaptation as a social process can create unrealistic expectations about achieving intended adaptation outcomes **”**

IPPC 2018. Report on Global Warming of 1.5 ºC. “Adaptation to 1.5°C global warming can also result in trade–offs or **maladaptations** with adverse impacts for sustainable development. For example, if poorly designed or implemented, adaptation projects in a range of sectors can increase greenhouse gas emissions and water use, increase gender and social inequality, undermine health conditions, and encroach on natural ecosystems (**high confidence**).”

UNEP 2019: Maladaptation is discussed in UNEP’s report *Frontiers 2018/19: Emerging Issues of Environmental Concern*, “strategies for adaptation need to address vulnerabilities and increase resilience on a global scale, and avoid short-term fixes that may only have local benefits. It is becoming clear that international cooperation and planning are needed to avoid adaptations that may appear to offer mitigation, but which actually compound the problem.**”**

Three basic observations

1. all agents want to react against a threat to their well-being, but not all agents have the same ability to react to a given threat: differentiated effects even when environmental problems affect all agents equally
2. people usually choose defensive strategies which offer instant remedy but do not tackle the causes of the problem
3. sometimes defensive strategies increase the severity or extent of the threat

The model

- $Y_i = A_i \cdot L_i$, *i = R; P.*
- $A_R > A_P$
- $Q_i := Q + dD_i$
- $\dot{Q} = q(Q_w - Q) - e(\bar{Y}_P + \bar{Y}_R)$ if $Q > 0$;
  $\dot{Q} = 0$ if $Q = 0$

- Two agents: *R*−agent, *P*−agent.
- Q_i the quality of the environmental goods to which each agent has access
- Q : the quality of common access environmental resources
- D_i , *i = R; P*: defensive expenditures
- Q_w is the value that the variable Q would approach in absence of economic activity
- $e>0$,
- $\bar{Y}_P, \bar{Y}_R$: the average values of the output Y_P, Y_R

The model

In each instant of time t, the representative *i-agent*, *i = P,R*, chooses the values of the control variables L_i , C_i and D_i that solve the following optimization problem

$$\max_{C_i, D_i, L_i} U_i(C_i, Q, D_i, L_i) = C_i^{\alpha} \cdot (\bar{L} - L_i)^{\beta} \cdot Q_i^{\gamma}$$

subject to the constraints:

$$A_i \cdot L_i = C_i + D_i$$
$$Q_i = Q + dD_i$$
$$C_i \geq 0, L_i \geq 0, D_i \geq 0$$

With $\alpha, \beta, \gamma > 0, \alpha + \beta + \gamma = 1$

The solutions of the problem varying the quality index Q

	$Q \leq \overline{Q}_P = \frac{\gamma d A_P \overline{L}}{1-\gamma}$	$\overline{Q}_P < Q < \overline{Q}_R$	$Q \geq \overline{Q}_R = \frac{\gamma d A_R \overline{L}}{1-\gamma}$
C_P^*	$\frac{\alpha}{d}(A_P d\overline{L} + Q)$	$\frac{A_P \alpha \overline{L}}{1-\gamma}$	$\frac{A_P \alpha \overline{L}}{1-\gamma}$
C_R^*	$\frac{\alpha}{d}(A_R d\overline{L} + Q)$	$\frac{\alpha}{d}(A_R d\overline{L} + Q)$	$\frac{A_R \alpha \overline{L}}{1-\gamma}$
D_P^*	$\gamma A_P \overline{L} - \frac{1-\gamma}{d} Q$	0	0
D_R^*	$\gamma A_R \overline{L} - \frac{1-\gamma}{d} Q$	$\gamma A_R \overline{L} - \frac{1-\gamma}{d} Q$	0
$\mathbf{L_P^*}$	$(1-\beta)\overline{L} - \frac{\beta}{A_P d} Q$	$\frac{\alpha}{1-\gamma}\overline{L}$	$\frac{\alpha}{1-\gamma}\overline{L}$
$\mathbf{L_R^*}$	$(1-\beta)\overline{L} - \frac{\beta}{A_R d} Q$	$(1-\beta)\overline{L} - \frac{\beta}{A_R d} Q$	$\frac{\alpha}{1-\gamma}\overline{L}$

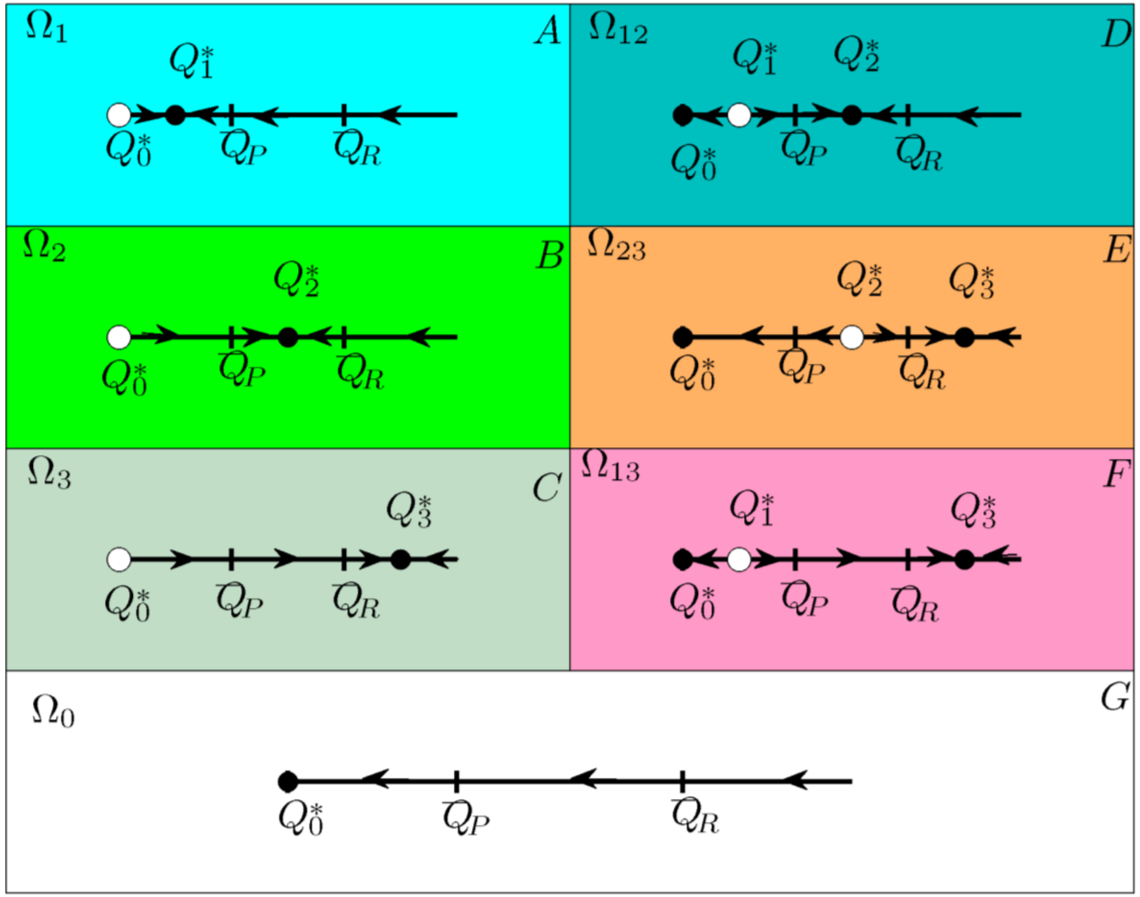
Stationary states and dynamic regimes

Convergence to low environmental quality →

Convergence to medium environmental quality →

Convergence to high environmental quality →

Environmental collapse →



← Path dependence

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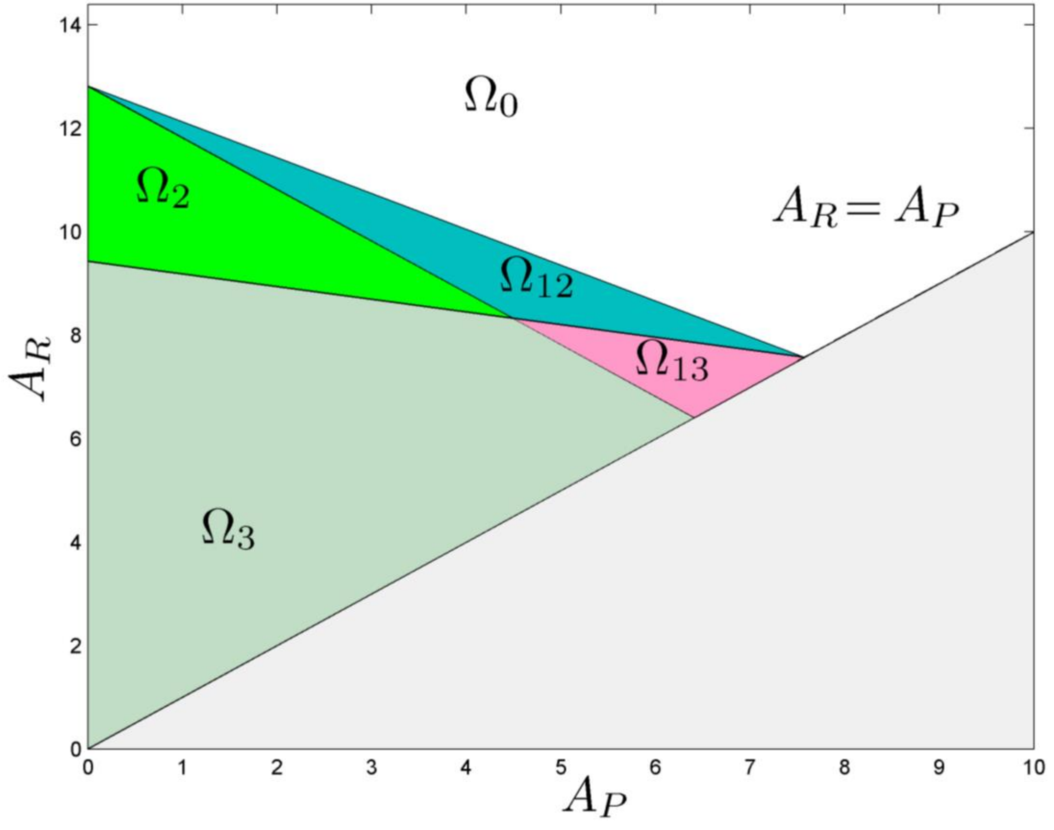
The Key question: high (low) inequality → high (low) environmental quality?

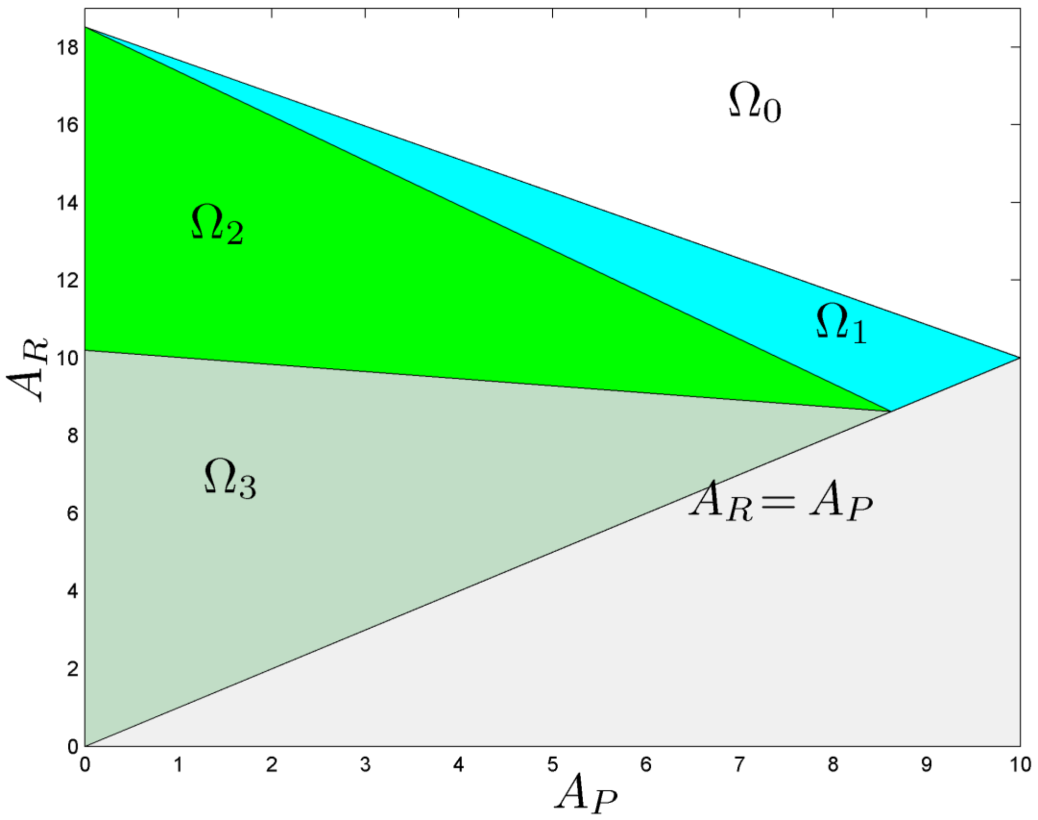
Economic inequality measured by $A_R - A_P$



$$\frac{dq}{2\beta} < e < \frac{dq}{\beta}$$

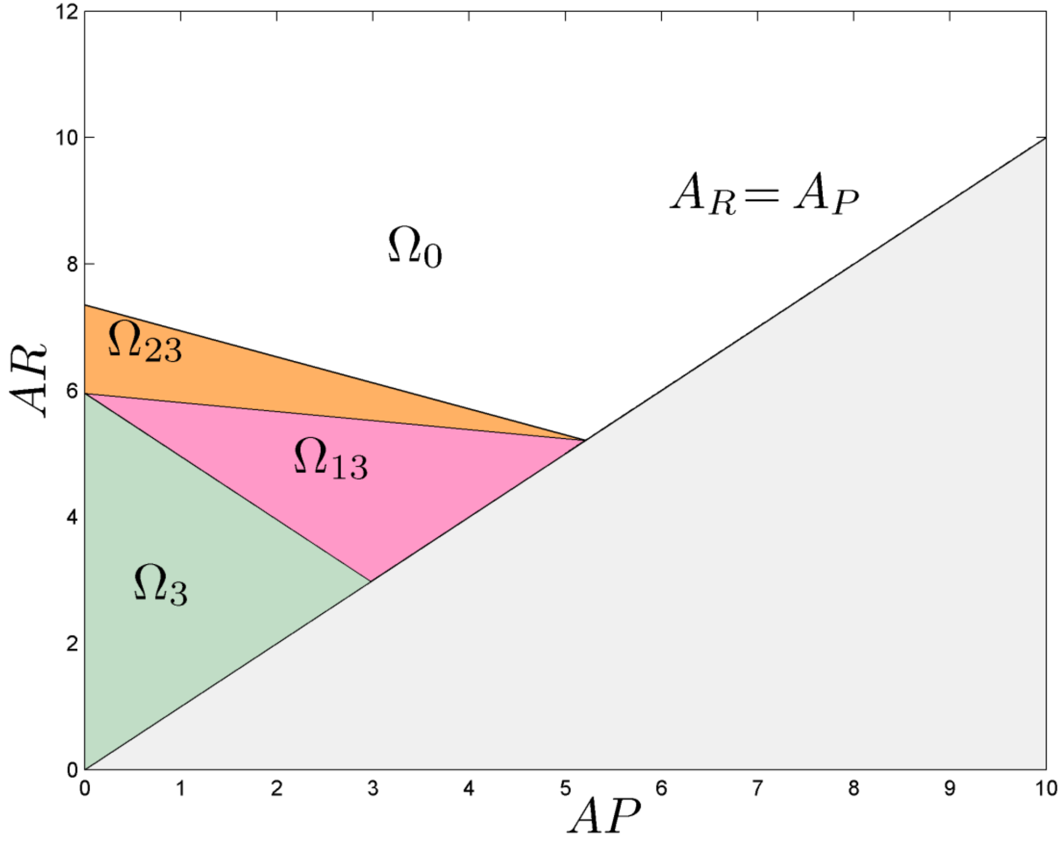
- **Economies with high poverty levels and low economic inequality** (i.e. low A_P , and low $A_R - A_P$) → regions Ω_3 → Q_3^* no defensive strategies and high environmental quality.
- **Economies with intermediate poverty levels and low economic inequality.** (i.e. intermediate A_P and low $A_R - A_P$) → Ω_3, Ω_{13}, Ω_{12} → convergence to high level of Q regardless the initial conditions or if $Q(0) > Q_1$.
- **Economies with high poverty levels and high economic inequality** (i.e. low A_P and high $A_R - A_P$) → Ω_0 vicious circle of **maladaptive growth**
- **Economies with intermediate poverty levels and high economic inequality.** (i.e. intermediate A_P and high $A_R - A_P$) → Ω_0 **maladaptive growth**
- **Rich economies with low poverty levels** (i.e. high A_P) → Ω_0 vicious circle of **maladaptive growth** or Ω_1 low environmental quality

Low pollution rate *e*



(a) $e < \frac{dq}{2\beta}$

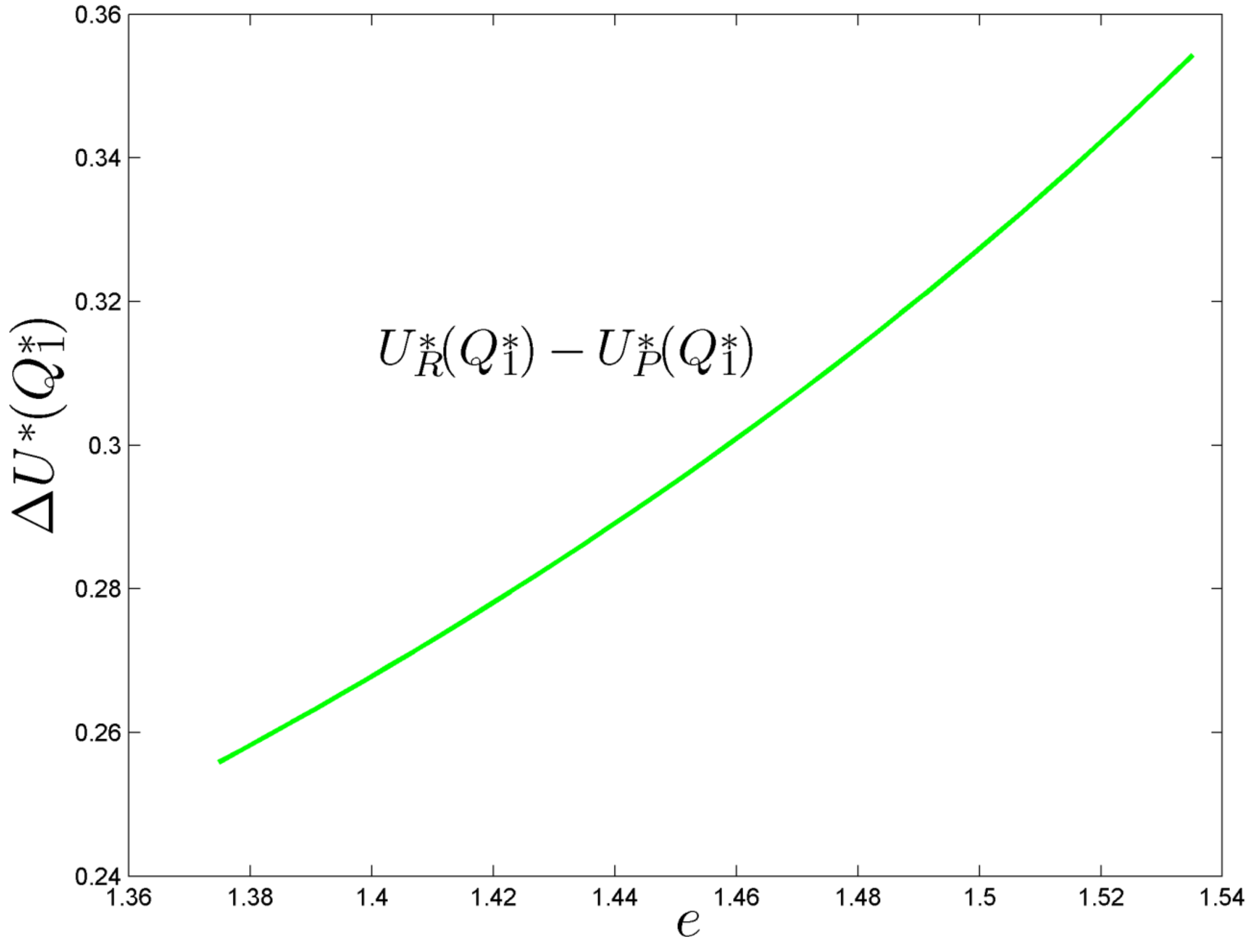
High pollution rate *e*



(c) $e > \frac{dq}{\beta}$

High (low) degree of environmental impact → high (low) **wellbeing** inequality?

Economic (exogenous) inequality measured by $A_R - A_P$
Wellbeing inequality measured by $U_R(C_R, Q, D_R, L_R) - U_P(C_P, Q, D_P, L_P)$



Equilibrium values of output and well-being inequality at the stationary state Q_1^* (where all agents defend themselves) varying the degree of environmental impact *e*

Final notes

- Wealth societies and inegalitarian economies are at risk to fall into a *vicious circle of maladaptive growth*

- The region of environmental collapse becomes wider as the parameter e increases.

- Mitigation policies and policies to reduce economic inequality are components of the same agenda

- Reminder of main assumptions: no demand of environmental quality, no policy response. Focus on maladaptation