
POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

# What role for decision making under uncertainty in climate policy analysis? Brief overview of some recent work at PIK

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# Acknowledgment

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Lorenz A, Schmidt MGW, Kriegler E, Held H (2012): ***Anticipating Climate Threshold Damages***. Environmental Modeling and Assessment 17: 163-175.

Lorenz A, Kriegler E, Held H, Schmidt MGW (2012) ***How important is Uncertainty for the Integrated Assessment of Climate Change?*** Climate Change Economics 3(1): 1250004.

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Schmidt MGW, Held H, Kriegler E, Lorenz A (2013) ***Climate Policy Under Uncertain and Heterogeneous Climate Damages***, Environmental and Resource Economics 54:79-99.

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# Key question: When does DMU make a difference?

**Comparison of welfare and policy outcome in:**

- Best guess deterministic optimization: $max_c\, W(c,E(\vartheta))$
- Expected value stochastic optimization: $max_c\, E(W(c,\vartheta))$

**Observations from the literature**

- there can be large differences in cost-effectiveness settings (e.g. Held et al., 2009)
- mostly small differences in cost-benefit settings (e.g. Nordhaus, 1994, 2008). Exceptions are studies with catastrophic damages, fat tails, tipping points.

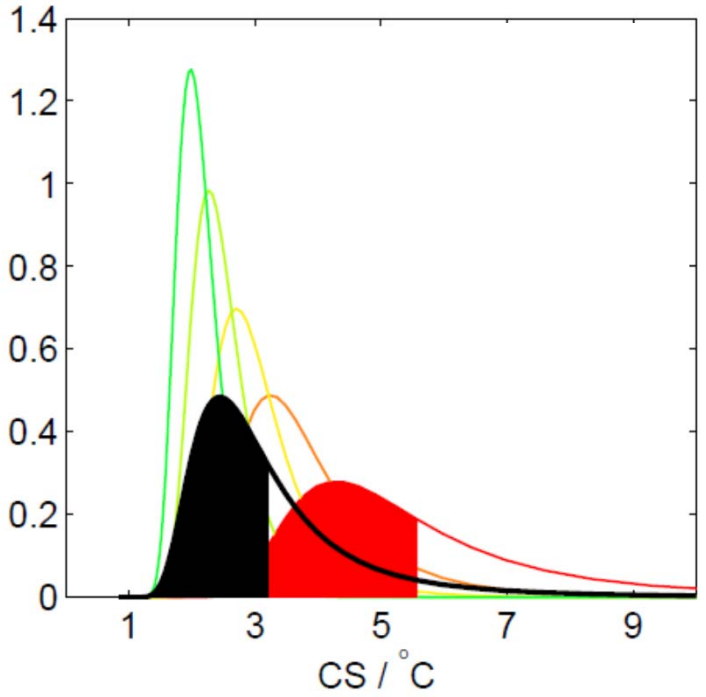
# Cost-effectiveness setting

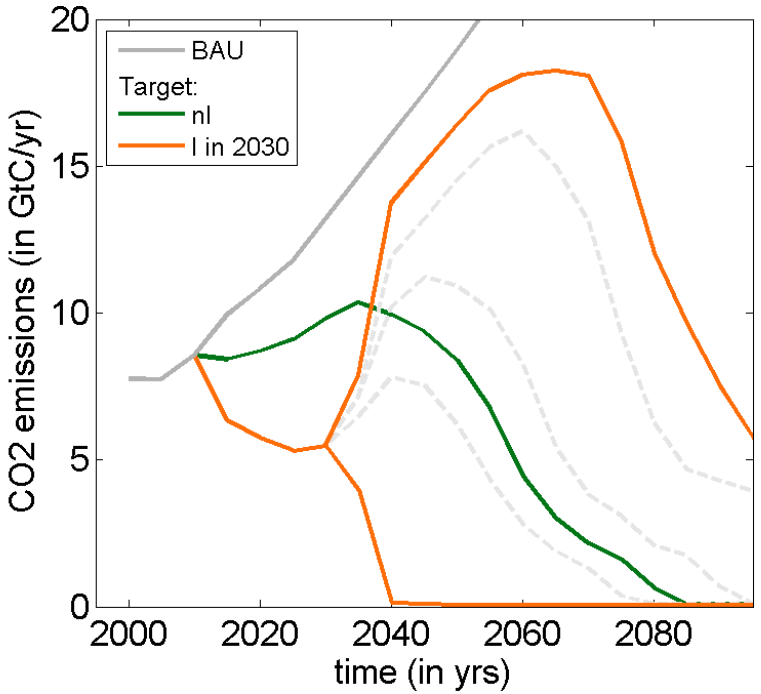
**Chance constrained programming (CCP),** if uncertainty about emissions & climate outcome is incorporated

- e.g. maximize welfare subject to reaching 2°C with > 50% probability (Held et al., Energy Economics 31, 2009)

**Conceptual problems of CCP in dynamic settings (Schmidt et al., CCL, 2011)**

- negative value of information (or infeasibility) if a posterior after learning runs against constraint
- first period decision can be heavily influenced in CCP setting due to impossibility to relax constraint

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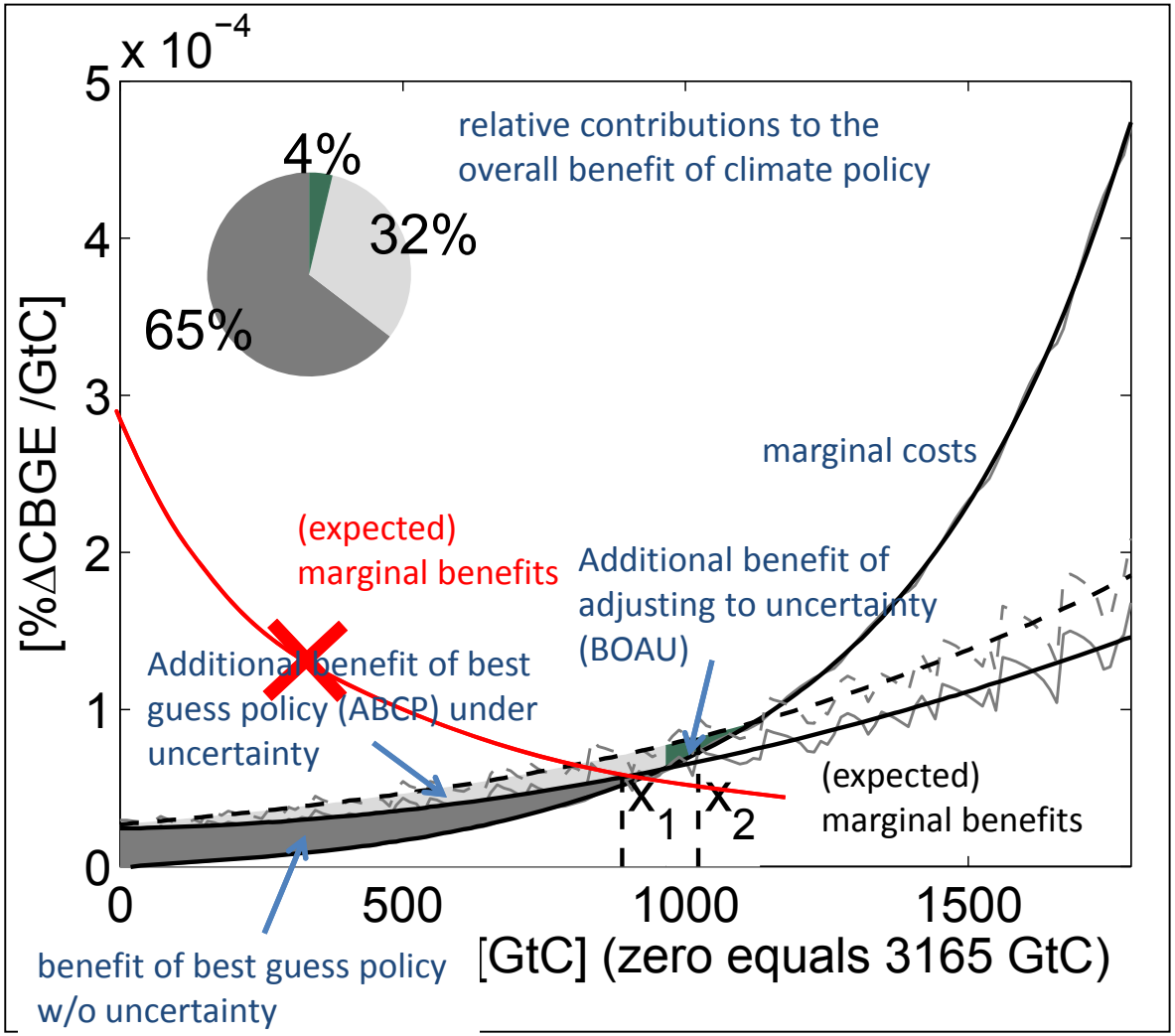
# Cost-benefit setting (Lorenz et al., CCE, 2012)

**Reasons for small difference between best-guess and exp. value optimization:**

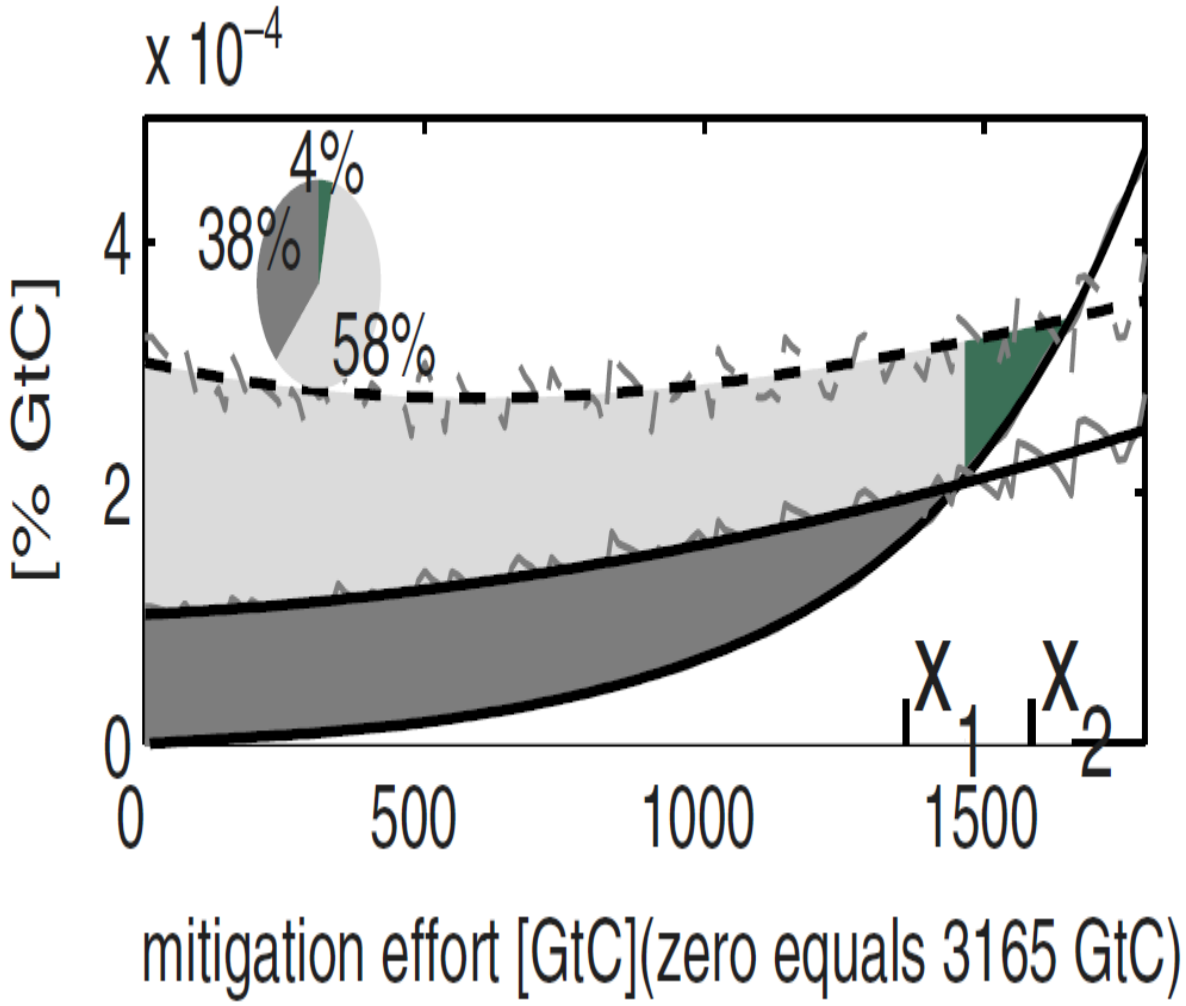
- **ABCP small:** Non-linearity of climate damage function overcompensated by saturation of emissions to ΔT relationship plus welfarization of damages (➔ discounting)
- **BOAU small:** strongly increasing mitigation costs.



# Cost-benefit setting (Lorenz et al., CCE, 2012)

**What makes a larger difference between best-guess and exp. value optimization?**

- Increase non-linearity of damage function (quadratic to exponential)
- linear cumulative emissions to ΔT relationship



# Uncertain and heterogenous climate damages (Schmidt et al., ERE 2013)

**Part 1: Uncertainty**

- Damages $D \sim N(\mu,\sigma)$ affect only a fraction $k < 1$ of the population
- Equal per capita consumption before damages: $y$
- Consumption of affected individuals: $c_1 = y - D/k$
- Certainty equivalent assuming CARA utility: $c^* = y - \mu/k - A/2\ \sigma^2/k^2$

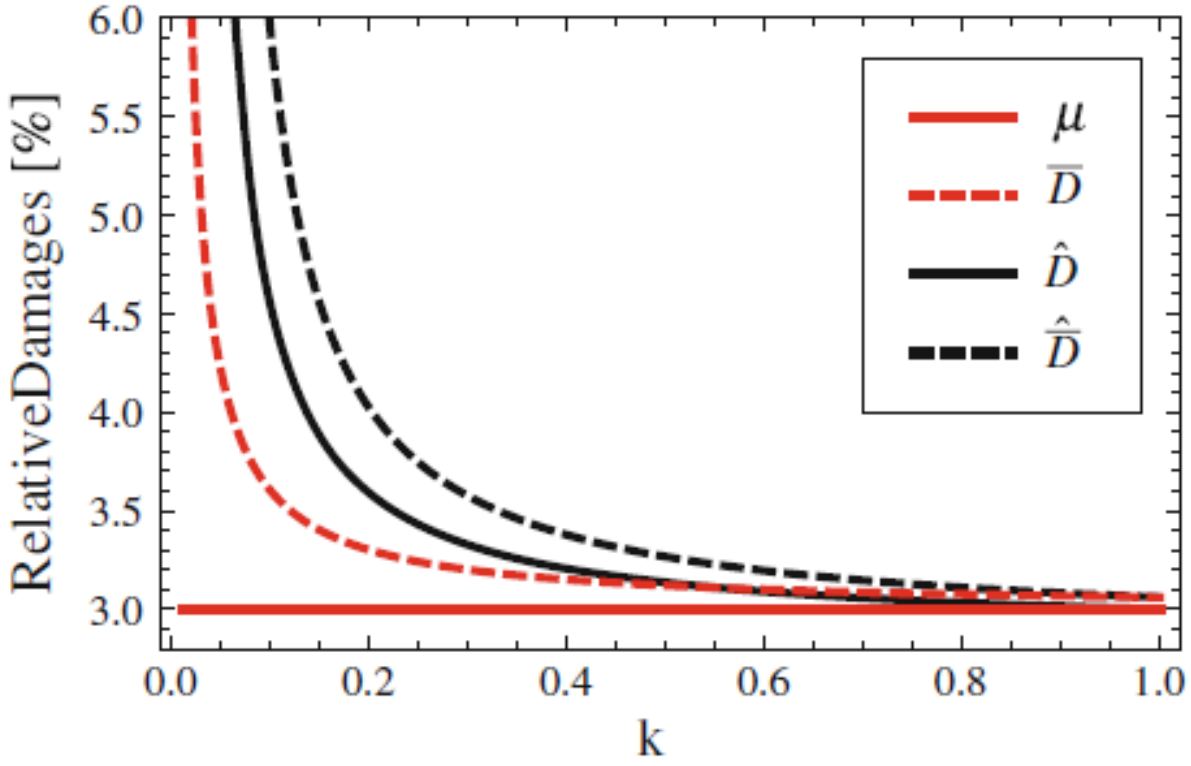
**Part 2: Inequality**

$W(c_1,c_2,k) = k\ v(c_1^*) + (1-k)\ v(c_2=y)$ with $v$ concave (e.g. of CARA type)

# Combined effect of risk & inequality aversion

**Four cases:**

- Society risk and inequality neutral (solid red)
- Society risk averse, but inequality neutral (dashed red)
- Society risk neutral, but inequality averse (solid black)
- Society risk and inequality averse (dashed black)



# Application to DICE

**Four cases:**

- Society risk and inequality neutral (solid red)
- Society risk averse, but inequality neutral (dashed red)
- Society risk neutral, but inequality averse (solid black)
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