Minimax Regret Discounting

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Department of Economics
Colorado State University

June 2012
Constant exponential discounting unsettling for long-lived environmental problems

Choice of discount rate all important

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Relative valuations “feel” implausible

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Declining discount rates (DDRs) do better on all three
Weitzman (1998)

If consumption discount rate (CDR) uncertain and apply Savage axioms (max EU) then certainty-equivalent CDRs decline to lowest possible rate
But estimating probabilities a challenge

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Assigning probabilities hard
Assume complete ignorance

- Policymakers face a set of welfare specifications, no basis for assigning probabilities

→ Decision under Knightian uncertainty

\[
\min_{a \in A} \max_{\gamma \in \Gamma} R(a, \gamma),
\]

where

\[
R(a, \gamma) = \left[ \max_{a \in A} W(a, \gamma) \right] - W(a, \gamma).
\]
Policymakers face a set of welfare specifications, no basis for assigning probabilities

\[ \rightarrow \text{Decision under Knightian uncertainty} \]

\[ \text{Minimax regret:} \]

\[
\min \max_{a \in A} R(a, \gamma), \quad \forall \gamma \in \Gamma
\]

where

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Justification for minimax regret

- Axiomatic foundations
  (Milnor 1954, Hayashi 2008, Stoye 2011)
Justification for minimax regret

- Axiomatic foundations
  (Milnor 1954, Hayashi 2008, Stoye 2011)

- Equally balances concern about “doing too little” with concern about “doing too much”
  (Iverson and Perrings 2011)
Minimax regret discounting mimics a criterion that maximizes PV of future utility with a path of certainty-equivalent discount rates that converges to the lowest possible rate.
Proposition 1: “as if” implicit prior

Consider a set of discounting models \( \Gamma = \{\gamma_1, \ldots, \gamma_m\} \)

- \( W(a, \gamma) \) concave in \( a \)
- Set of feasible policies convex and compact

Then, there exists a prior \( \pi = (\pi_1, \ldots, \pi_m) \)

such that MR maximizes

\[
E^\pi W(a, \gamma) = \sum_{i=1}^{m} \pi_i W(a, \gamma).
\]
The implicit minimax regret prior puts positive weight on the lowest discount rate model.
Calibrate expert disagreement to match Stern–Nordhaus debate

- Stern CDR: about 1.4%
- Nordhaus CDR: about 4.3%
Application

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- Solve for minimax regret solution in DICE (Nordhaus 2008)
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  - Stern CDR: about 1.4%
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- Solve for minimax regret solution in DICE (Nordhaus 2008)

The implicit MR prior puts positive weight on extreme models only:

\[ \hat{\pi} \] on the Stern model,
\[ 1 - \hat{\pi} \] on the Nordhaus model
Solving for minimax regret

\[ \hat{\pi} = 0.27 \]
Solving for minimax regret

- Stern
- \( p_S = 0.8 \)
- \( p_S = 0.6 \)
- \( p_S = 0.4 \)
- Minimax regret
- \( p_S = 0.2 \)
- Nordhaus
The effective CDR

Consumption discount rate (percent per year)

- Nordhaus
- Minimax regret
- Stern
Conclusion

- Reinforces Weitzman’s (1999) limiting result
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- Provides concrete resolution to discount rate uncertainty when prior unavailable

Quantitatively interesting: Applied to Stern–Nordhaus, effective CDR converges to Stern CDR within 200 years
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- Provides concrete resolution to discount rate uncertainty when prior unavailable
- **Quantitatively interesting:** Applied to Stern–Nordhaus, effective CDR converges to Stern CDR within 200 years
BACKUP
Time Inconsistency

- MR computed in 2015
- MR re-computed in 2065
Accommodating Time Inconsistency

- Consider alternative formulation to avoid time inconsistency concern
Accommodating Time Inconsistency

- Consider alternative formulation to avoid time inconsistency concern
- Accounting for time inconsistency increases near term abatement, so original formulation can be viewed as a lower bound