

# Climate change policy benefits and uncertainty

March 16, 2009

*Steve Newbold*

*U.S. EPA, National Center for Environmental Economics*

*The views expressed here are those of the author and  
do not necessarily represent those of the U.S. Environmental Protection Agency.  
No official Agency endorsement should be inferred.*

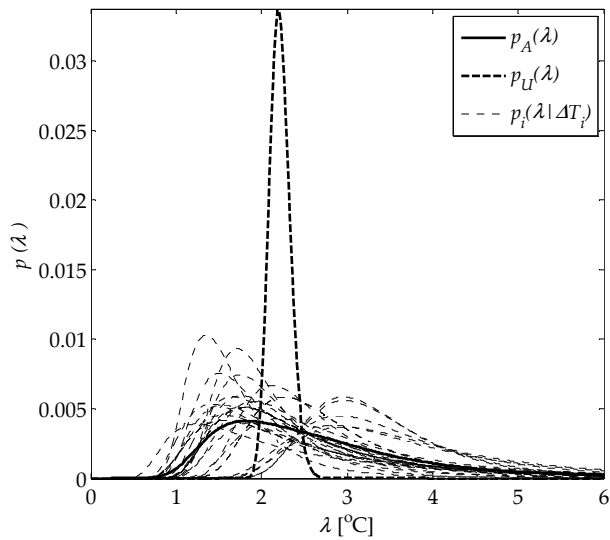
# Tiers of uncertainty analysis

1. *Ignore uncertainty.* Use deterministic model with best-guess/central parameter estimates.
2. *Sensitivity analysis over WTP.* Using deterministic model, show how WTP varies over a range of plausible input parameter values.
3. *Distribution of WTP.* Characterize uncertainty distributions for all input parameters and generate probability distribution for WTP.
4. *WTP based on expected utility theory.* Integrate over all uncertain inputs to find change in income that equalizes expected utility with and without the policy.

## ***How big? Some results so far...***

- Tol (2003), using FUND, found benefits could be unbounded.
- Weitzman (2009) showed analytically that if damages rise exponentially with temperature and the temperature pdf has a “fat tail,” then WTP is unbounded.
- Nordhaus (2008), using DICE, found a negative risk premium.
- Pindyck (2009), using a “thin tailed” gamma pdf for temperature, found a very small risk premium.
- Newbold & Daigneault (2009) constructed a posterior pdf using a form suggested by Roe & Baker (2007).

# Climate response uncertainty

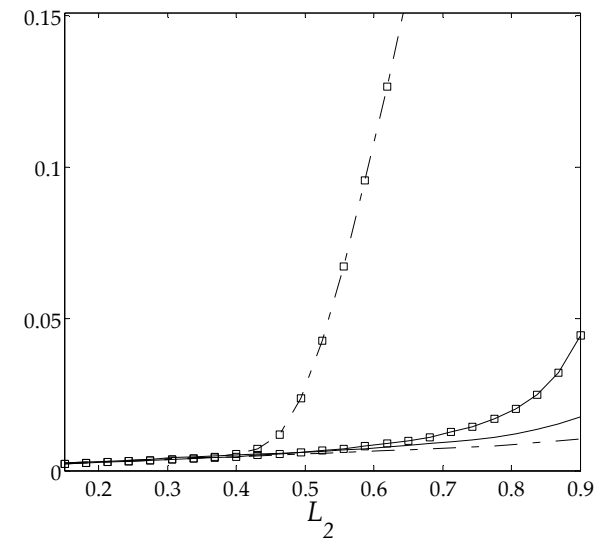
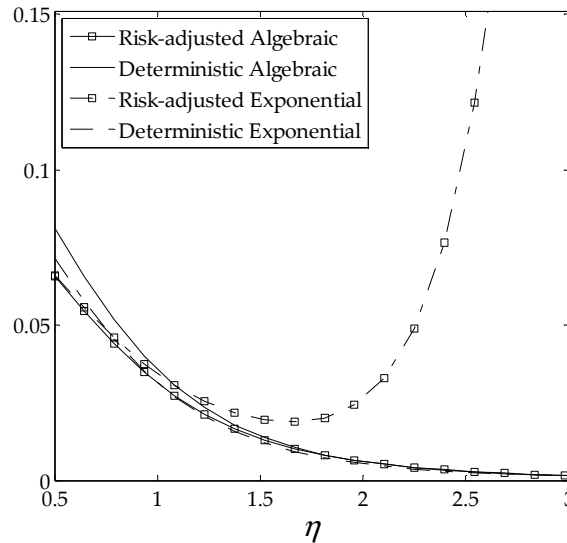
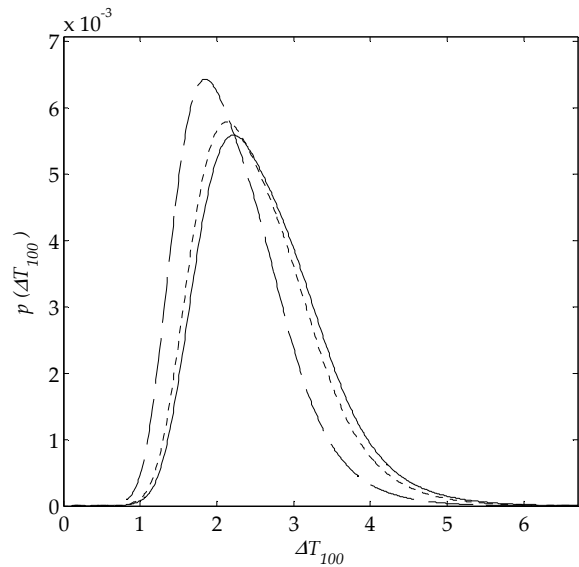


Algebraic Exponential

Bayesian model-averaged pdf:

*DICE optimal path:*

|                          |         |         |
|--------------------------|---------|---------|
| Deterministic <i>wtp</i> | 0.00610 | 0.00542 |
| Risk-adjusted <i>wtp</i> | 0.00610 | 0.02701 |



# “Practical recommendations...”

- Use expected utility theory and risk assessment tools.
- Define social welfare as expected NPV of the flow of aggregate utility through end of the planning horizon.
- Characterize uncertainty distributions for all inputs.
- Calculate social welfare for the status quo and policy scenario(s) for each combination of input parameters.
- Calculate \$ benefits of a policy as reduction in total income with the policy that would make social welfare equal to that without the policy.
- Analogous to WTP for an insurance policy.
- Applicable to one-time, irreversible decisions.

# “Improve decision making tools...”

- A (more) complete accounting of uncertainty in an IAM requires an *adaptive management*, or *stochastic dynamic programming*, approach.
- Specify current conditions: per capita consumption, population, emissions, temperature, pdf for climate sensitivity, etc.
- Specify probabilistic equations of motion for all state variables, conditional on control variables.
- Equation of motion for climate sensitivity pdf based on observed carbon concentration, temperature, and Bayesian updating.
- Solve for *optimal policy function*.

***Thank you***