

# Uncertainty Analysis of the MIT Integrated Global System Model

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MIT ESD



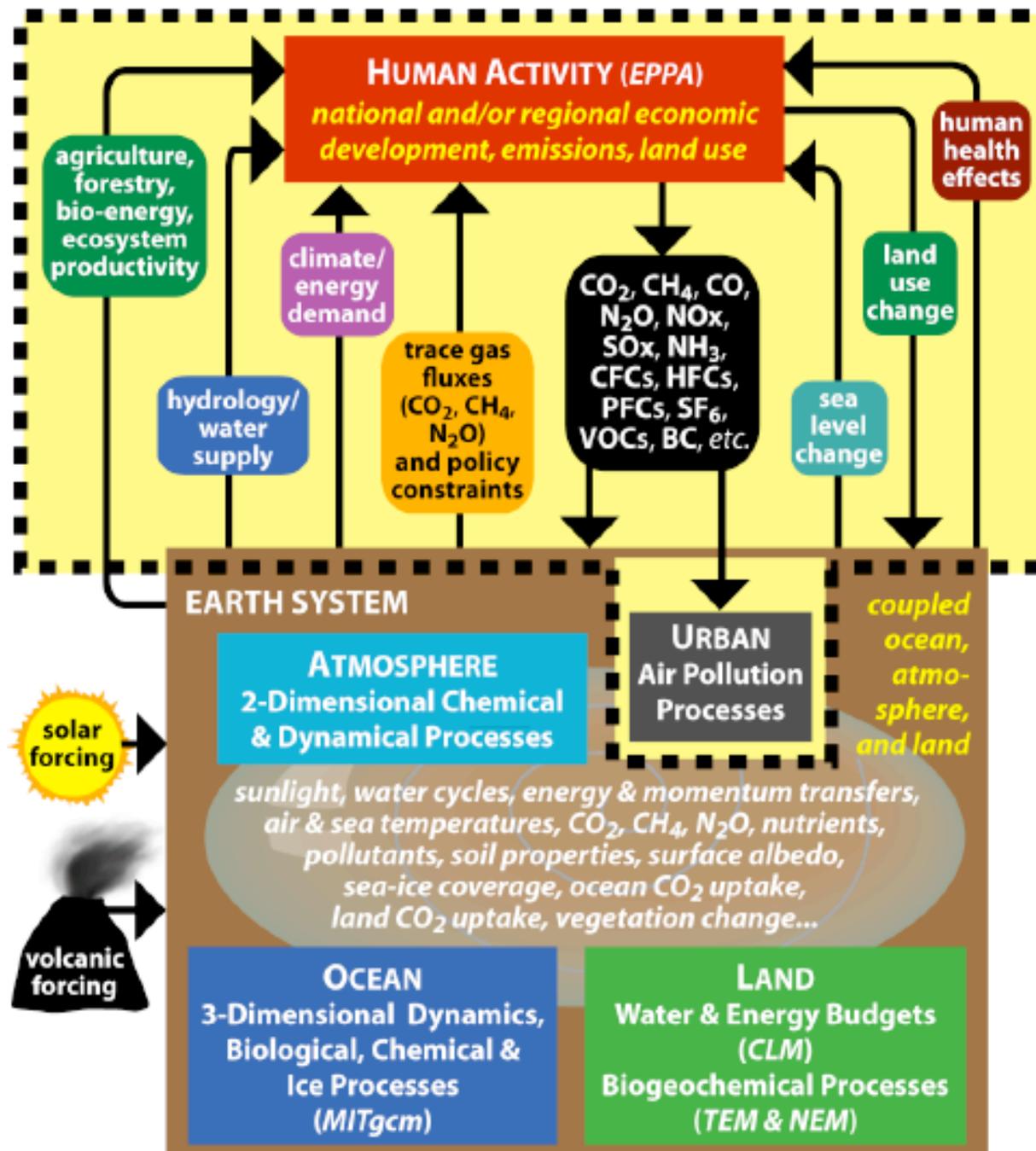
“Persons pretending to forecast the future shall be considered disorderly under subdivision 3, section 901 of the criminal code and liable to a fine of \$250 and/or six months in prison.”

Section 889, New York State Code of Criminal Procedure

# Outline

- Uncertainty Analysis of MIT IGSM
  - Uncertain Parameters and Sources
  - Policies examined
  - Key Results
- Thoughts about an Inter-model Comparison of Uncertainty
- Uncertainty Analysis vs. Decision Analysis

# MIT Integrated Global Systems Model



## EXAMPLES OF MODEL OUTPUTS

GDP growth, energy use, policy costs, agriculture and health impacts...

global mean and latitudinal temperature and precipitation, sea level rise, sea-ice cover, greenhouse gas concentrations, air pollution levels...

soil and vegetative carbon, net primary productivity, trace gas emissions from ecosystems, permafrost area...

# Uncertainties in EPPA

- (GDP) -> Labor Productivity Growth Rates
  - Historical Variability 1950-2000
  - Model as Random Walk with Drift
- Energy Efficiency (AEEI)
  - Absolute magnitude is model-dependent
  - Estimated Uncertainty of  $\pm 40\%$  ( $1 \sigma$ )
- Elasticities of Substitution
  - Econometric Studies

# Uncertainties in EPPA II

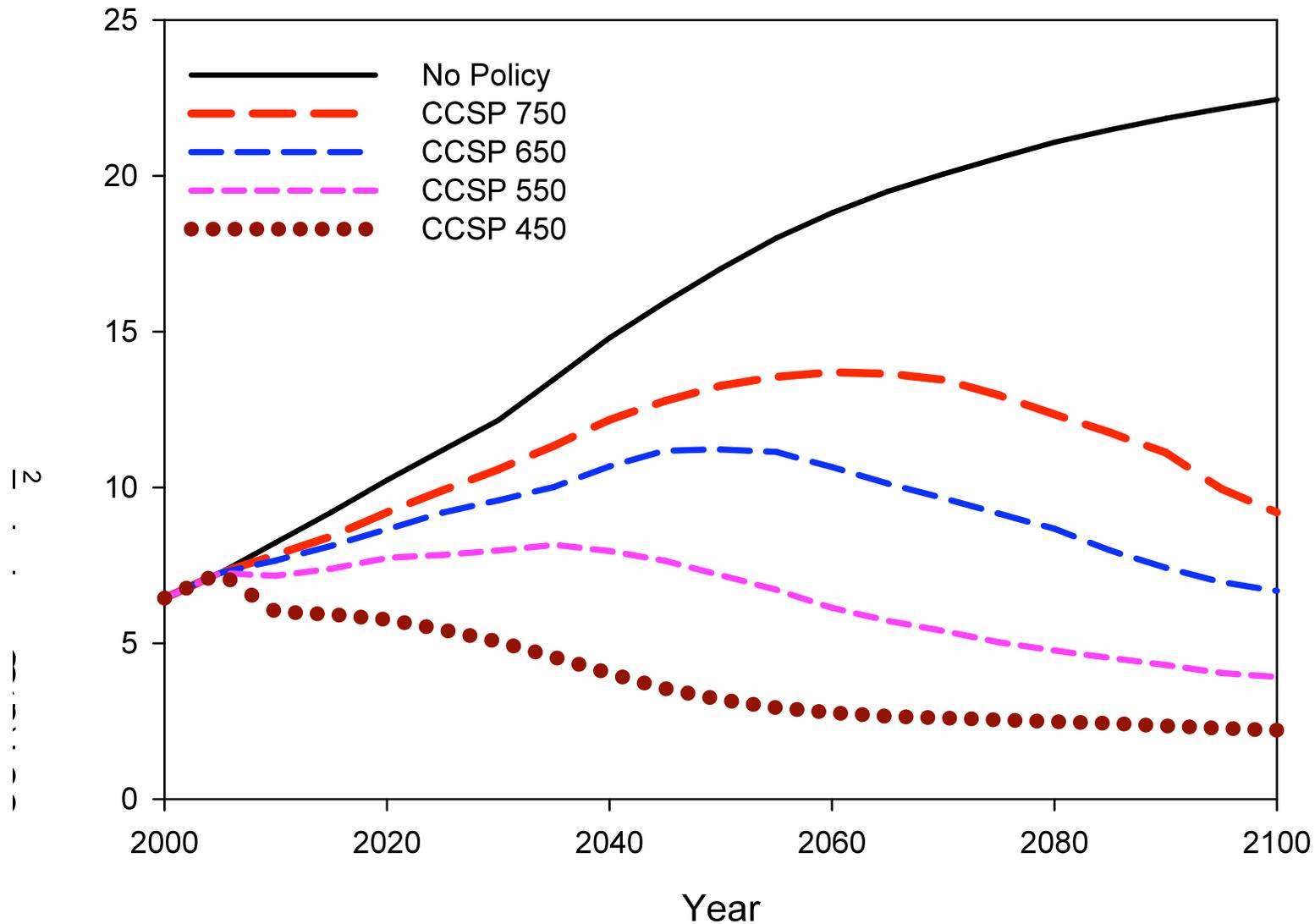
- Fossil Resources (Reserves)
  - USGS and other Probabilistic Assessments
- Population Growth
  - UNDP
- Future Technology Costs (Backstops + FF)
  - Expert Elicitation
- Non-CO<sub>2</sub> GHG Trends, Non-GHG Trends
  - Stern and others
- Capital Vintaging (expert elicitation)

# Uncertainties in Earth System

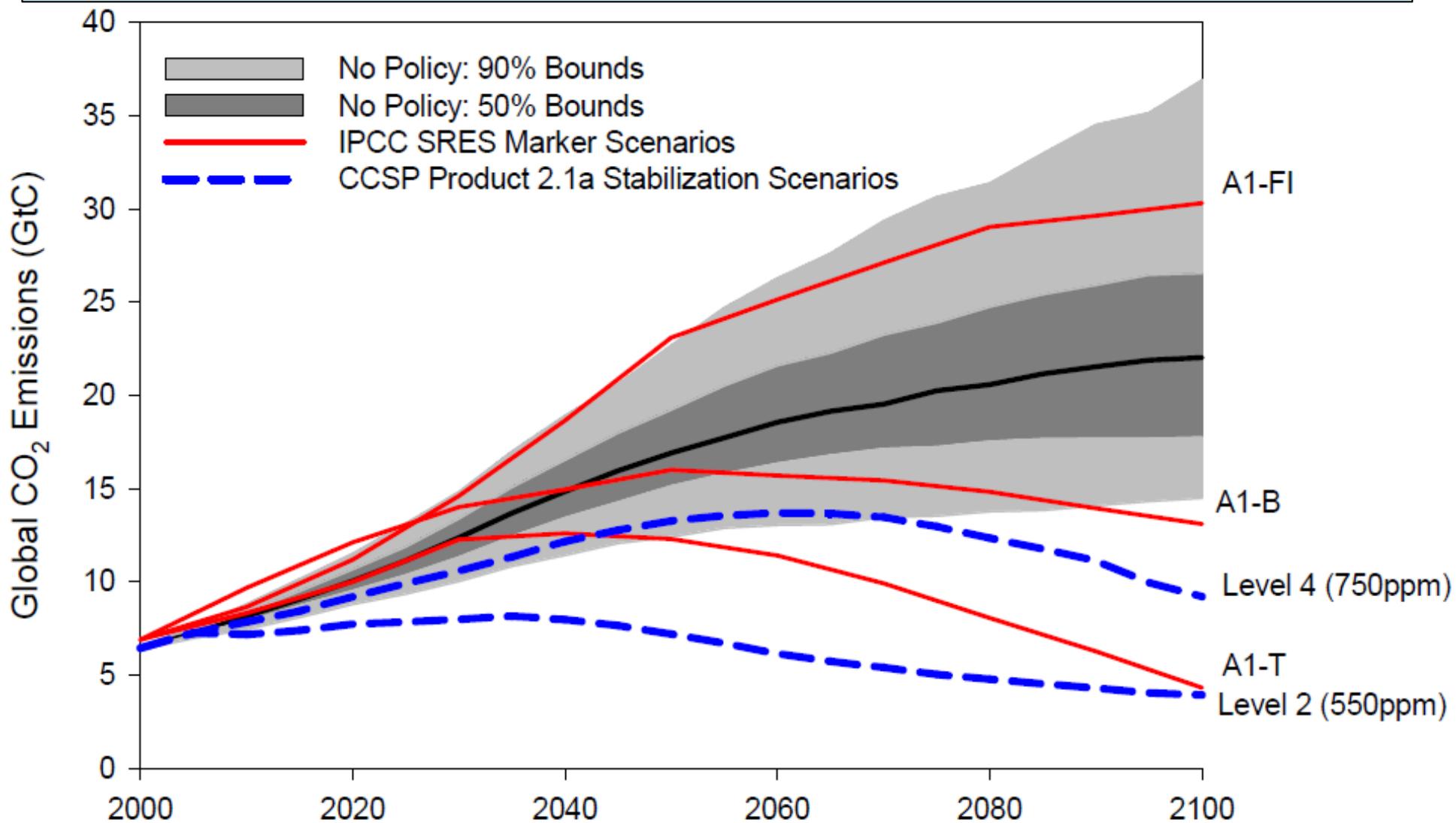
- Climate Sensitivity
  - Deep Ocean Uptake
    - (Heat and CO<sub>2</sub>)
  - Aerosol Forcing
  - Precipitation Patterns
  - CO<sub>2</sub> Fertilization
- 
- Samples Correlated
- Samples Correlated

# Stabilization Scenarios

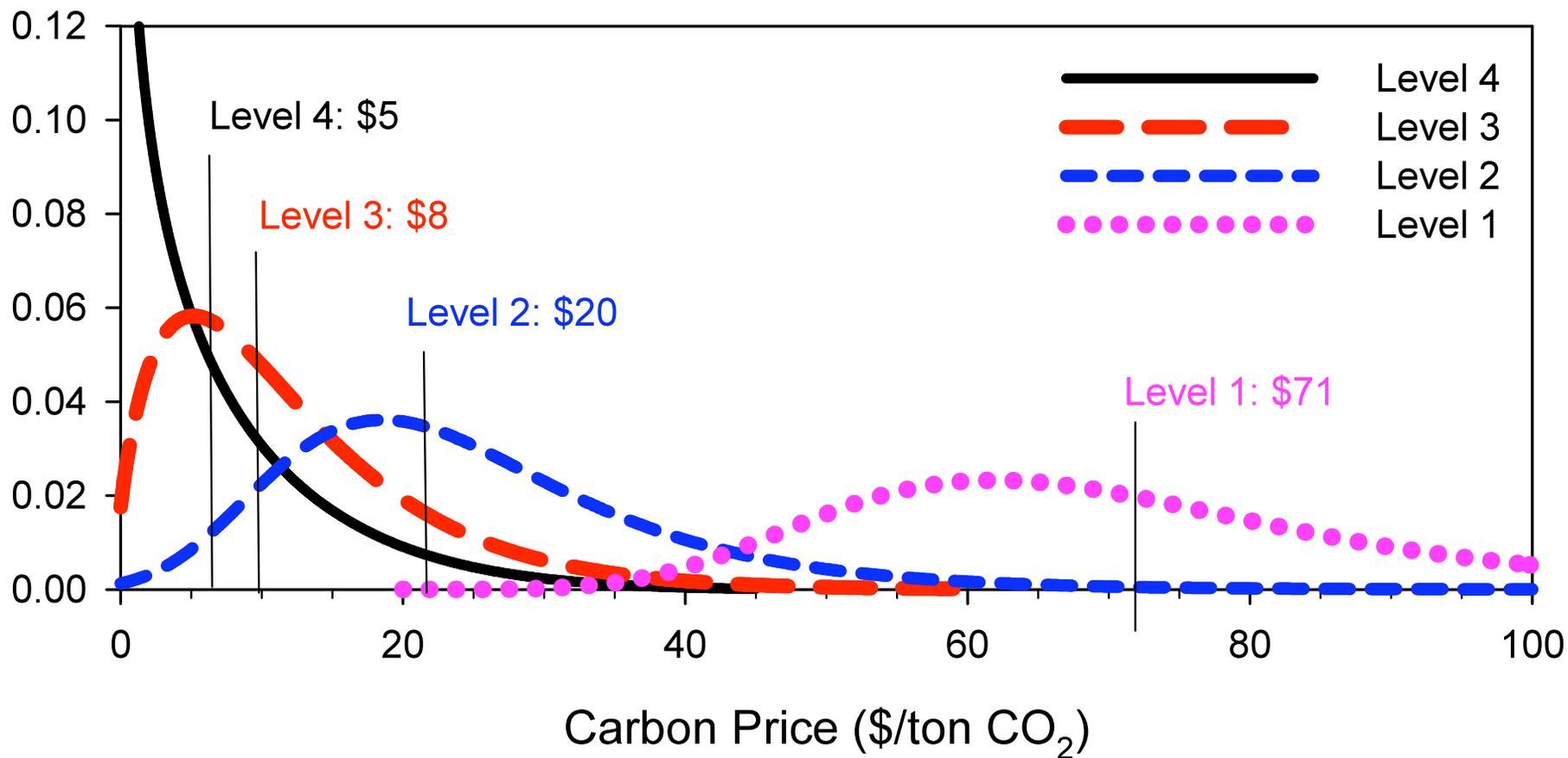
(Source: U.S. CCSP Product 2.1a)



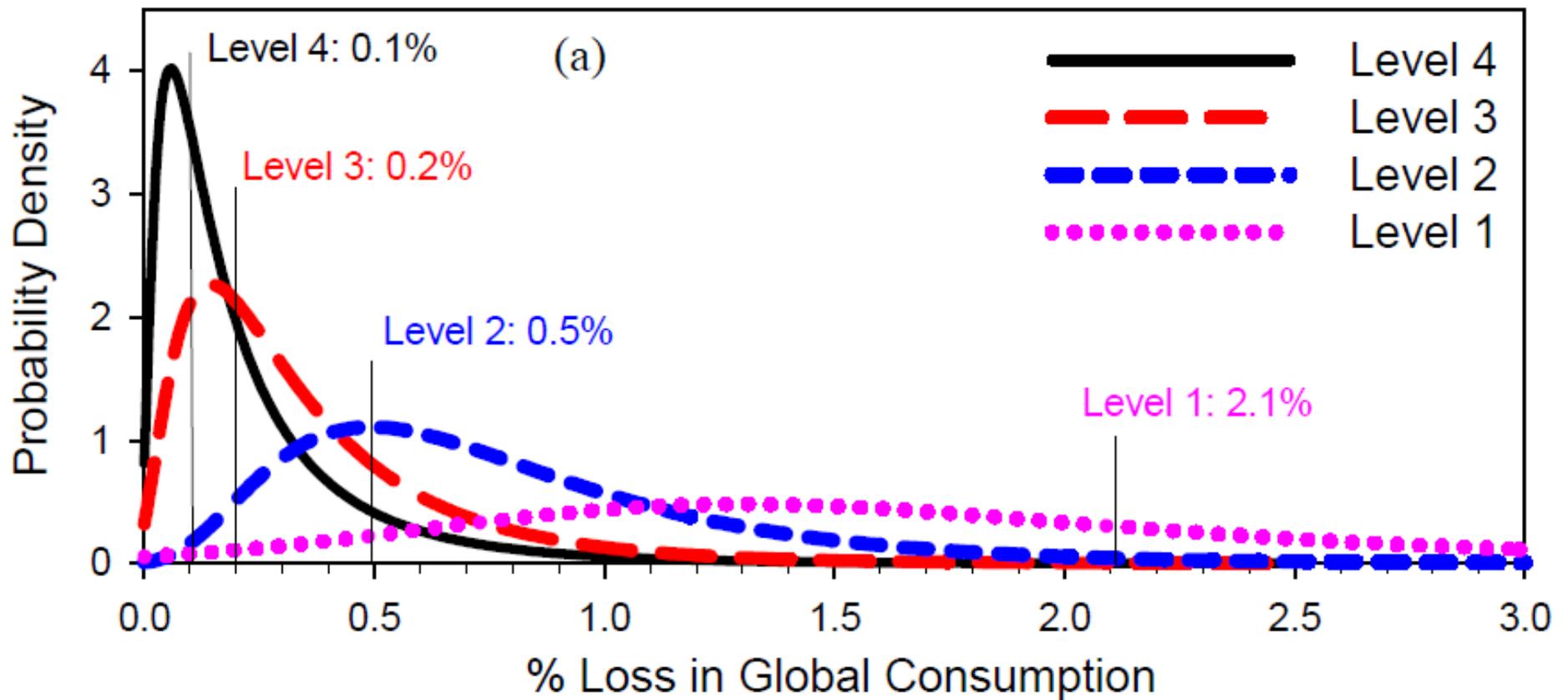
# Results: No Policy CO<sub>2</sub> Emissions



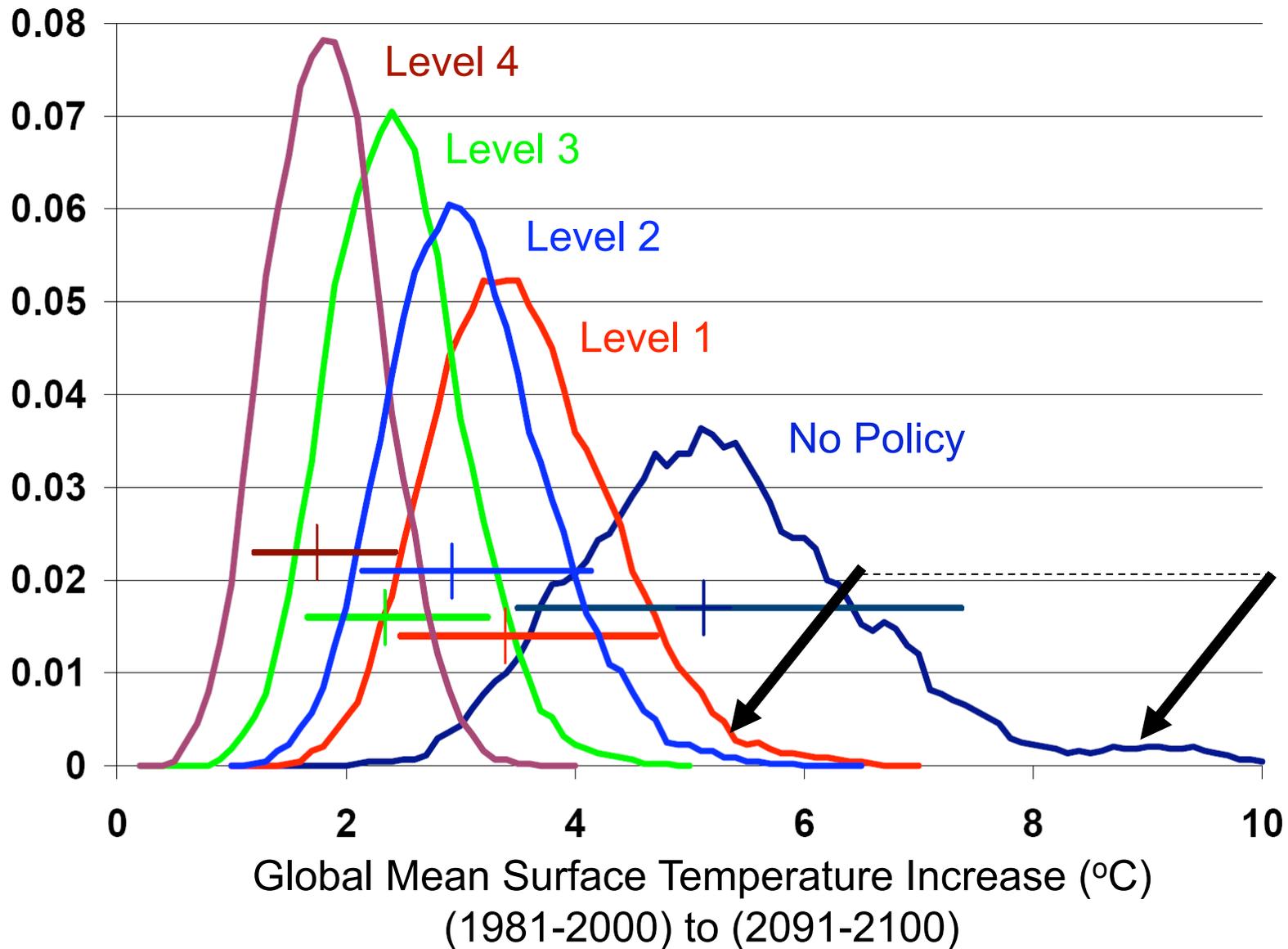
# Results: Carbon Prices in 2020



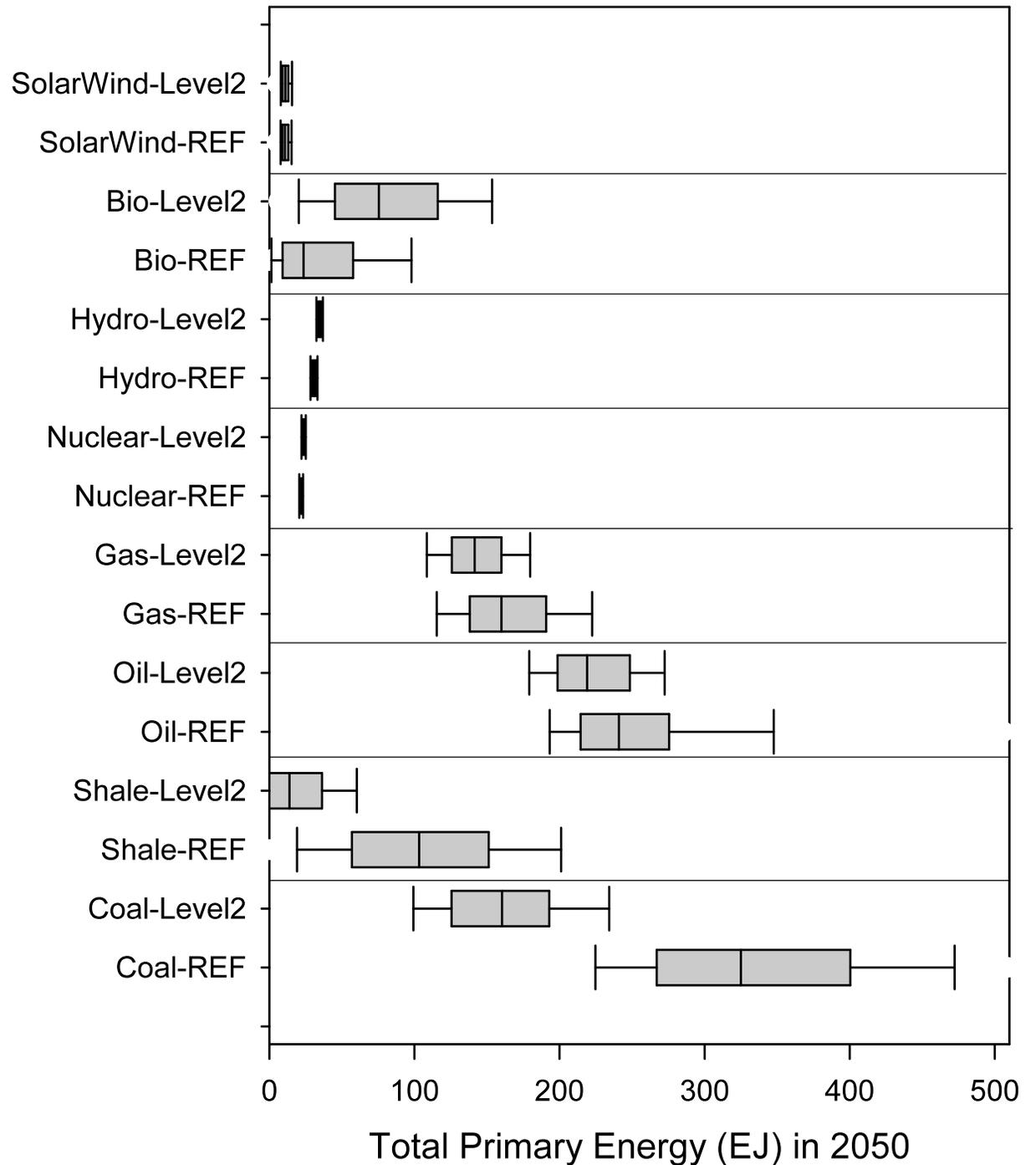
# Results: Welfare Loss in 2020



# Results: Temperature Change

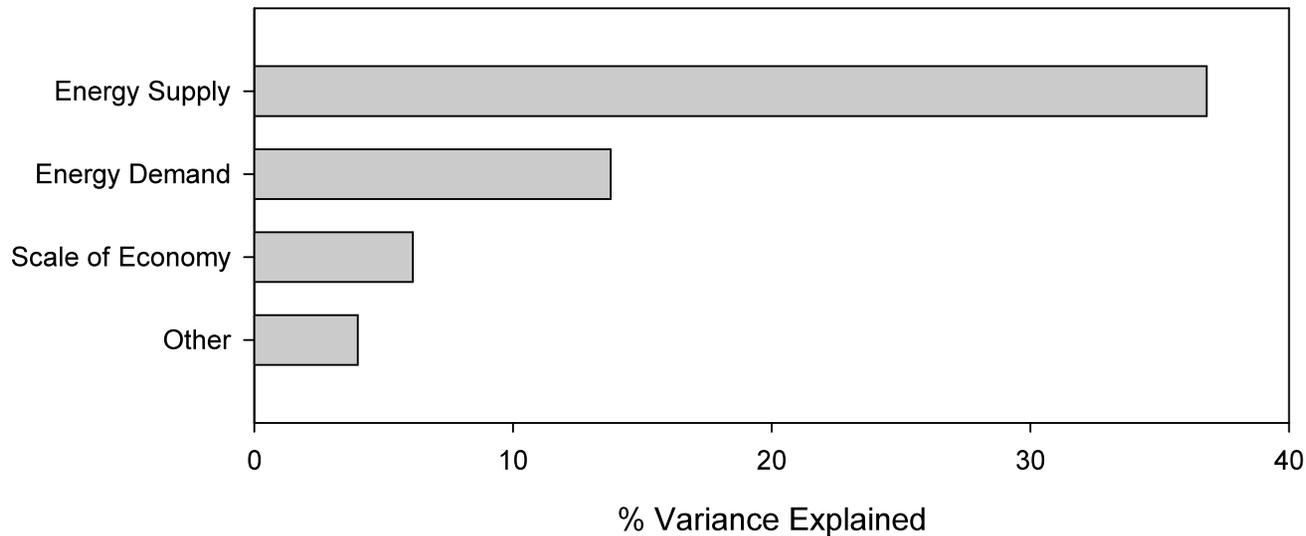


# Uncertainty in Total Primary Energy Sources 2050

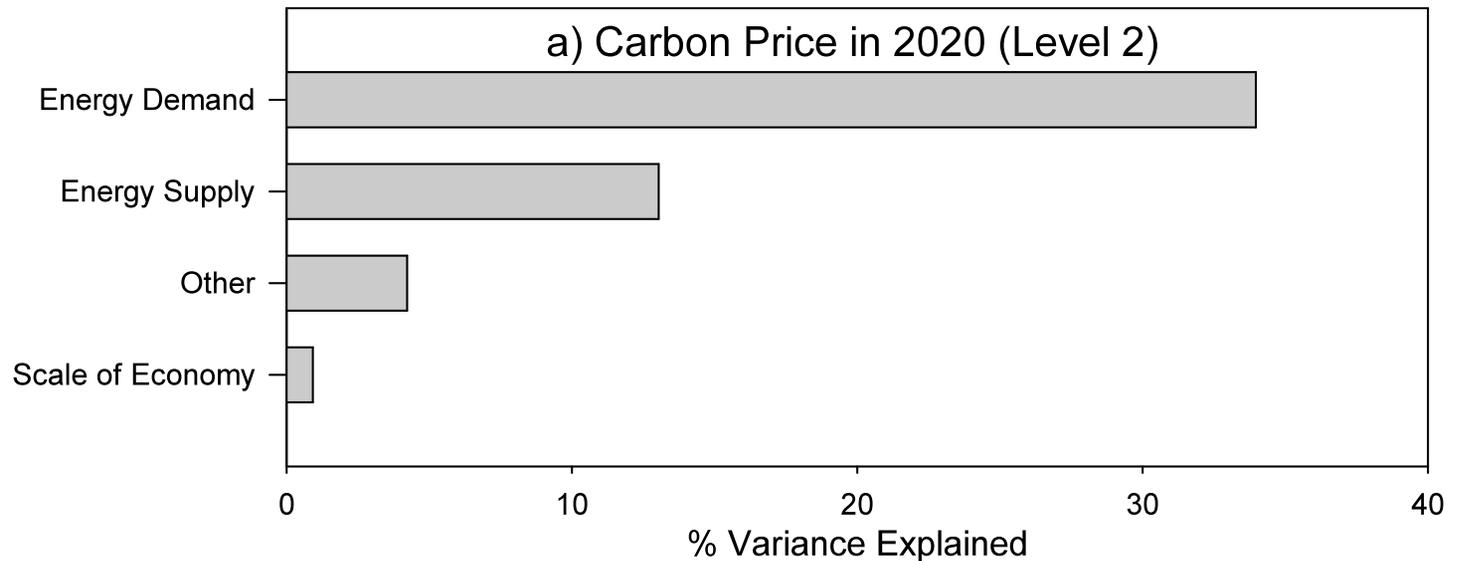


# Relative Contribution to Variance

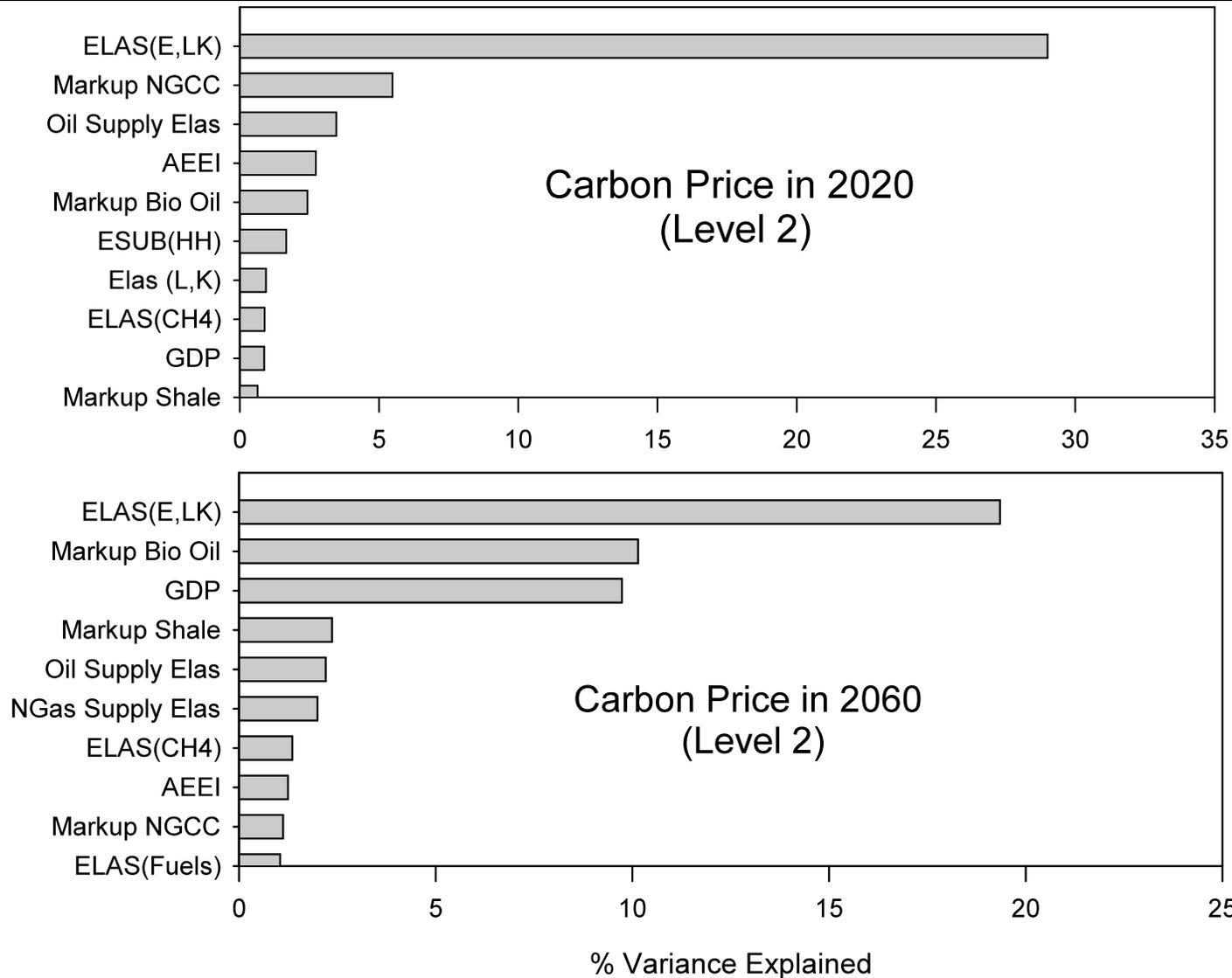
Cumulative Global CO<sub>2</sub> 2000-2100 (Reference)



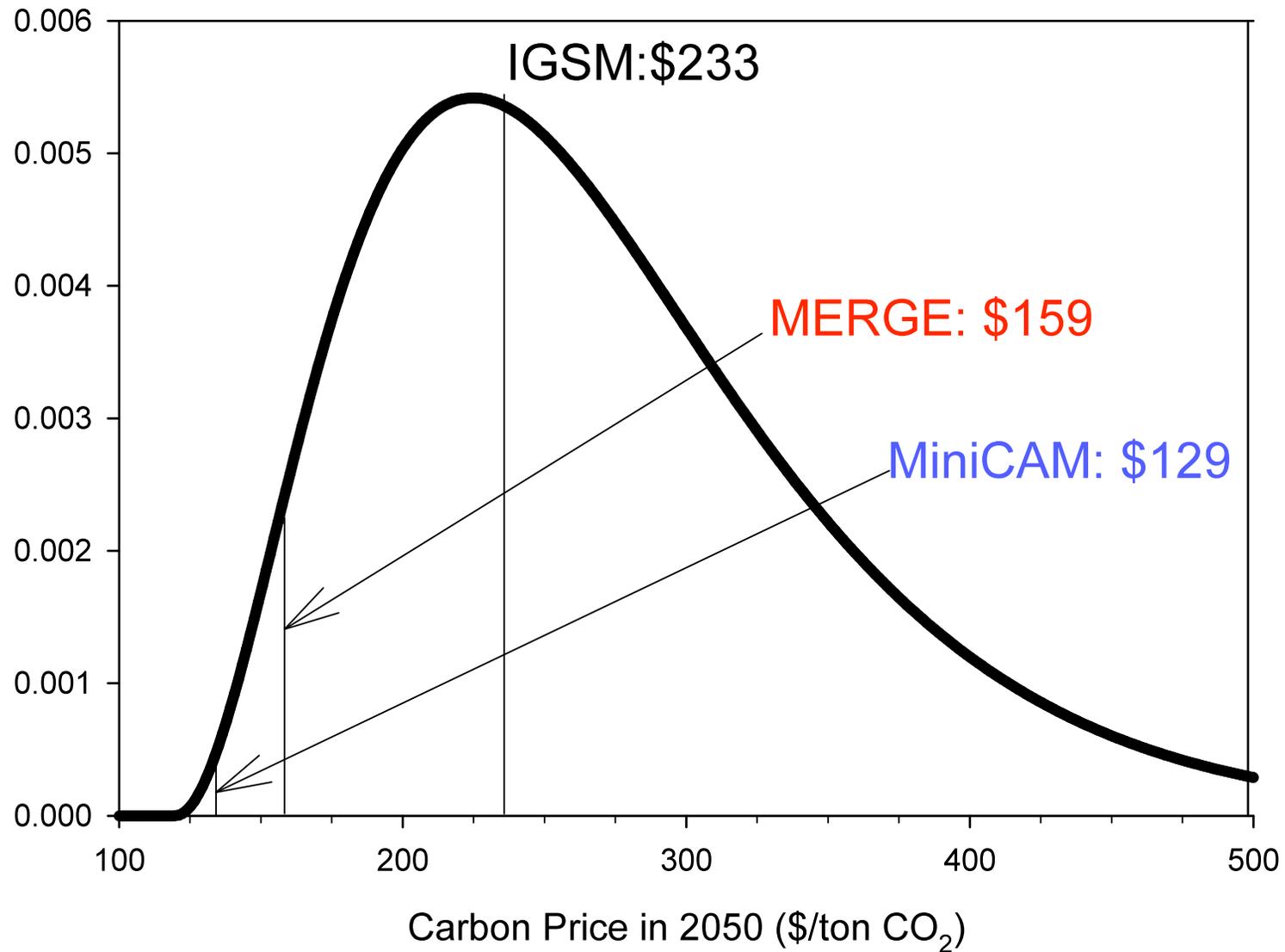
- Energy Supply
  - Energy Demand
  - Scale of Economy
  - Other Uncertainties
- Predict which most affect cum. CO<sub>2</sub>, carbon prices.*



# Top Ten Drivers of Uncertainty in Abatement Cost



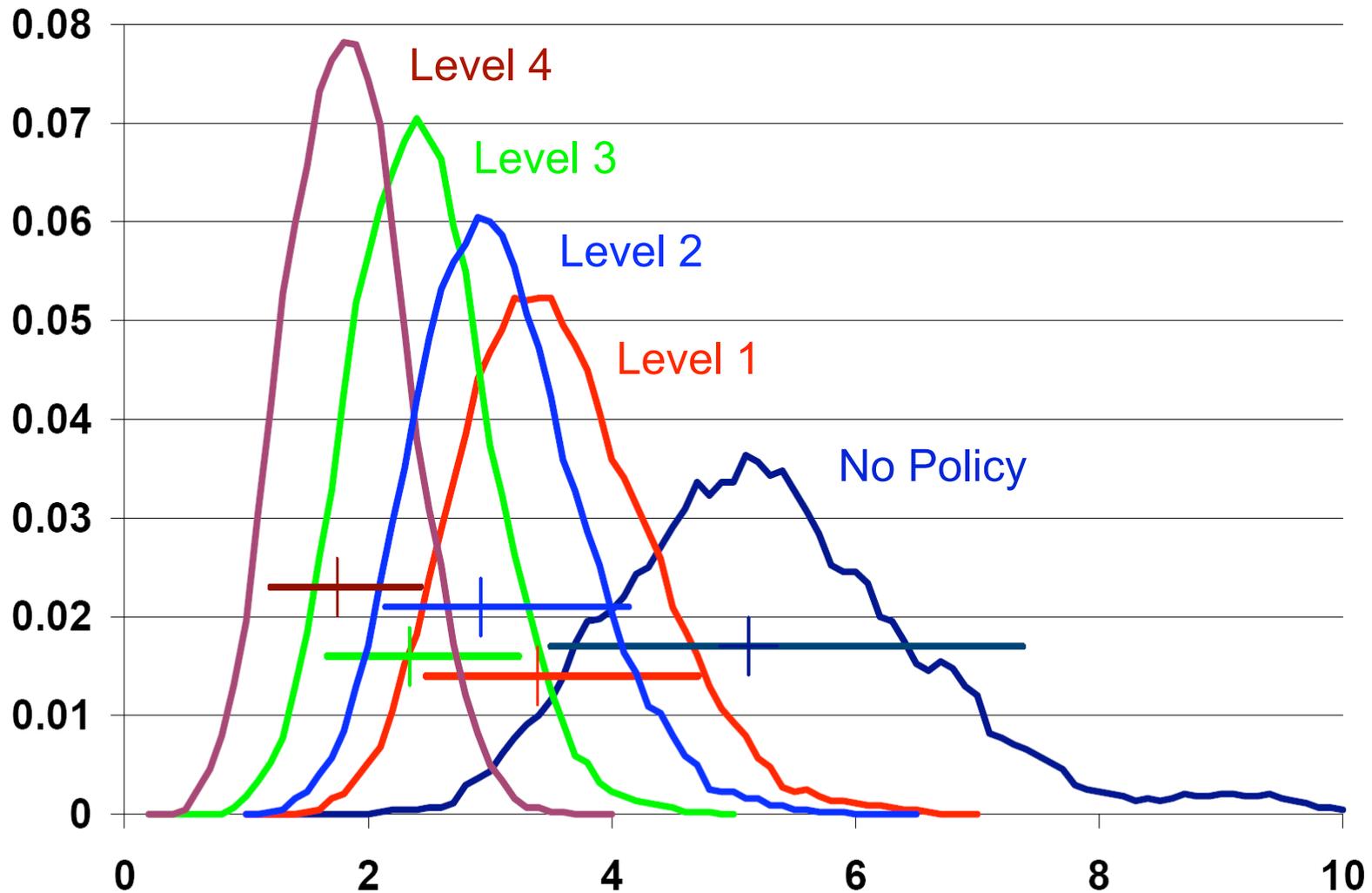
# Carbon Price Under Level 1 (~450ppm)



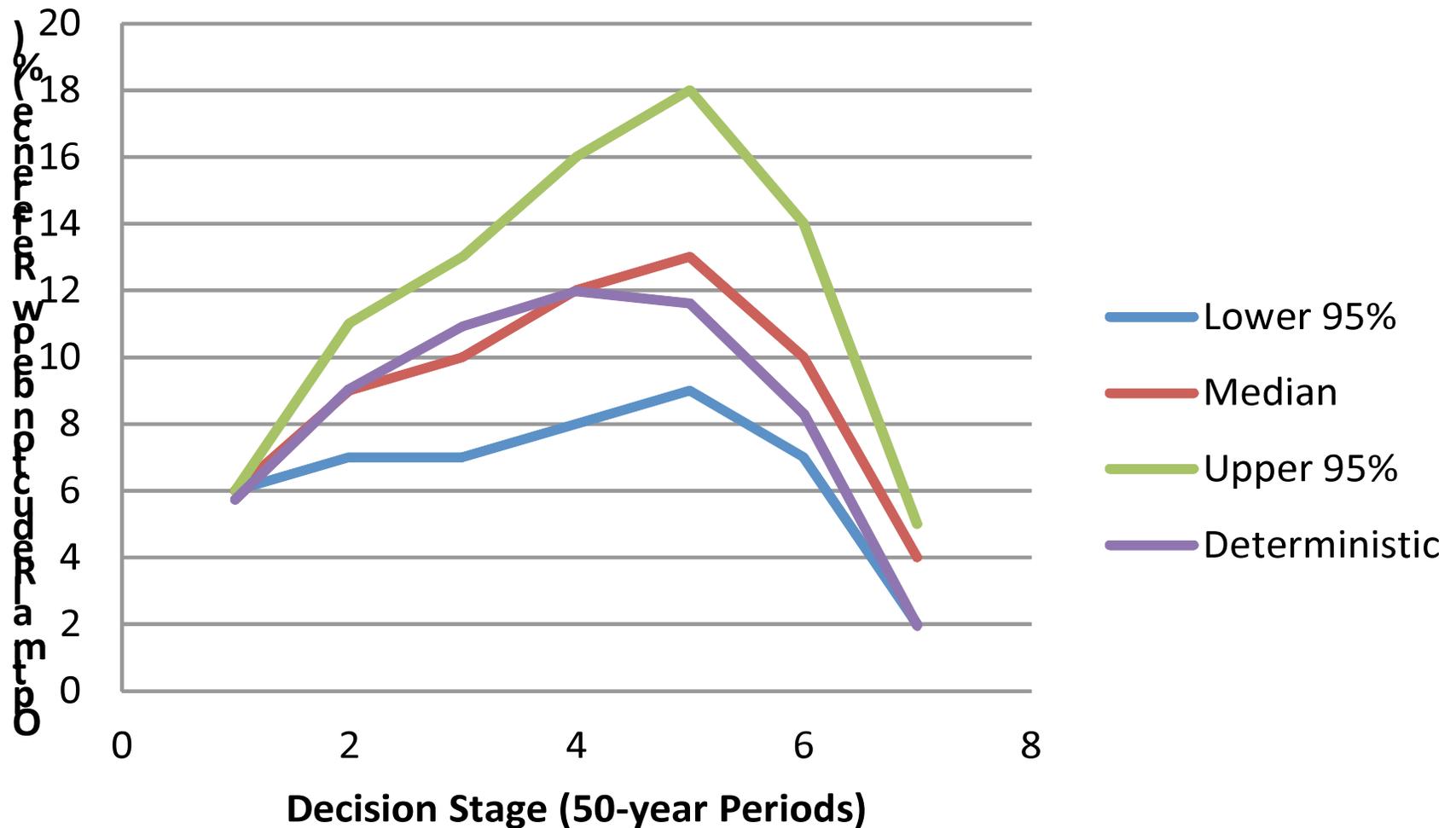
# Improvements for Inter-Model Comparison of Uncertainty

- Uncertainty Sources
  - Technology costs
  - Fossil resources and prices
  - Consistency across models
- Results
  - Regional costs depend on allocation scheme
  - Method for contribution to variance

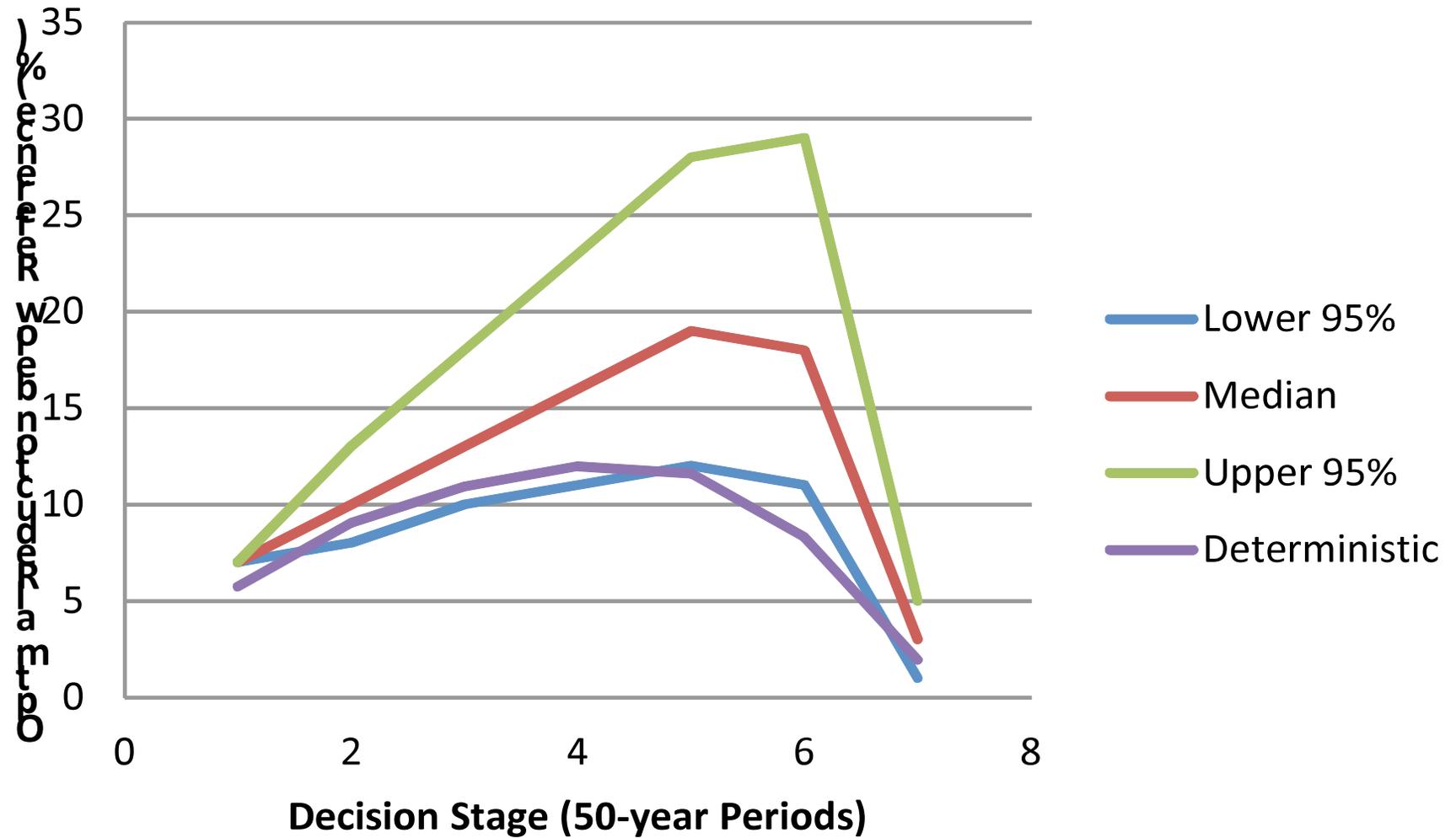
# Final Thought: What is the Question?



# Results of Stochastic Dynamic DICE



# Effect of Path-Dependence / Endogeneity



***Thank You!!!***