
Robust Strategies for Abating Climate Change

Robert J. Lempert
Senior Scientist
RAND

Complex Systems and Policy Analysis
September 28, 2000

Two Schools of Envisioning the Future

Analytic

Use formal tools such as forecasting, decision analysis

Deductive approach, combining data and models gives a rank ordering of strategies

Reveals fallacies in reasoning

Can not capture all the available information and has trouble representing flexible, adaptive strategies

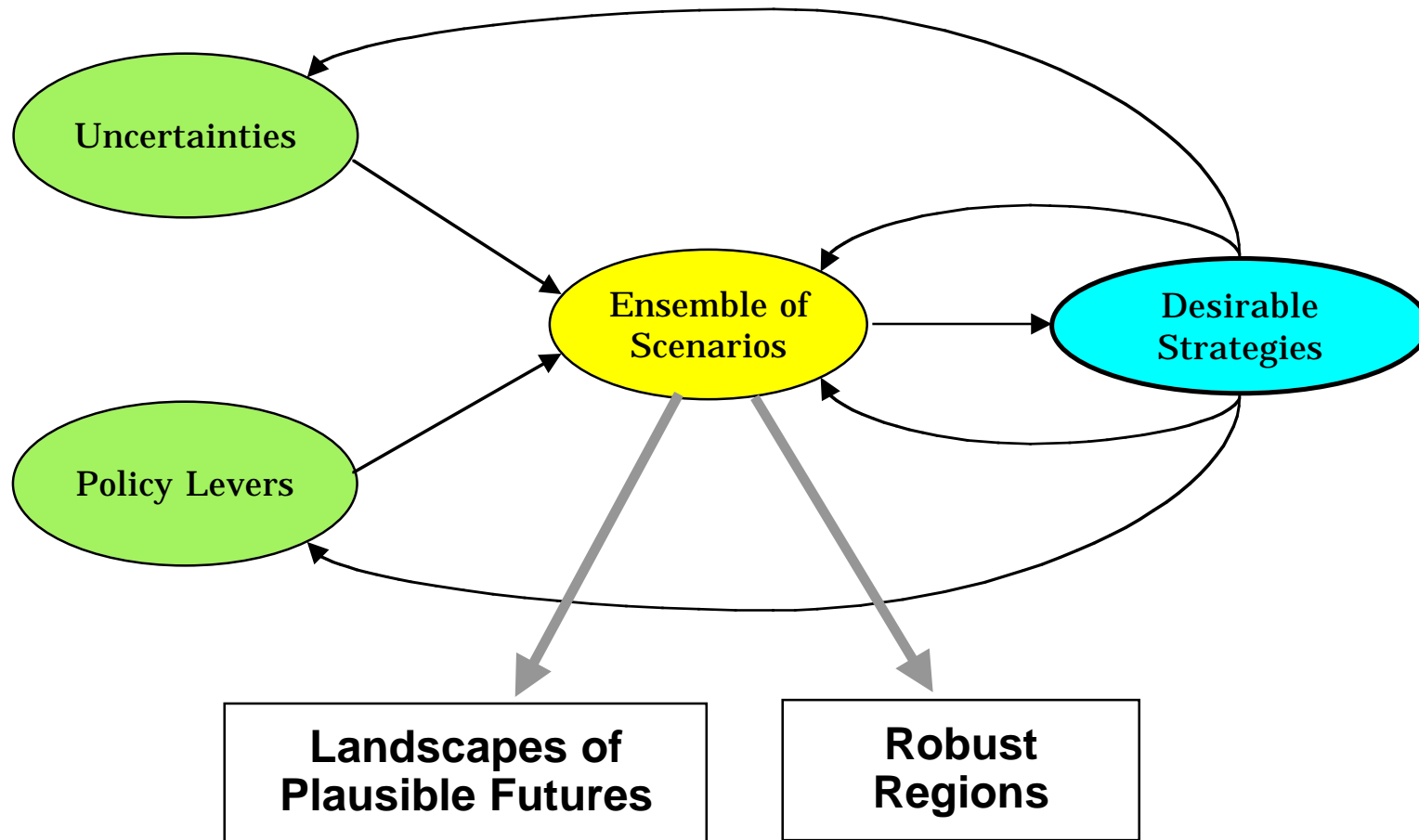
Narrative

Compare alternative scenarios, stories about the future

Multiple perspectives aids buy-in, reduces denial of risk, and may accelerate organizational learning

Does not capture all the available information nor systematically compare options

To Combine Analytic and Narrative, Use Computer as Search Engine, Not a Calculator



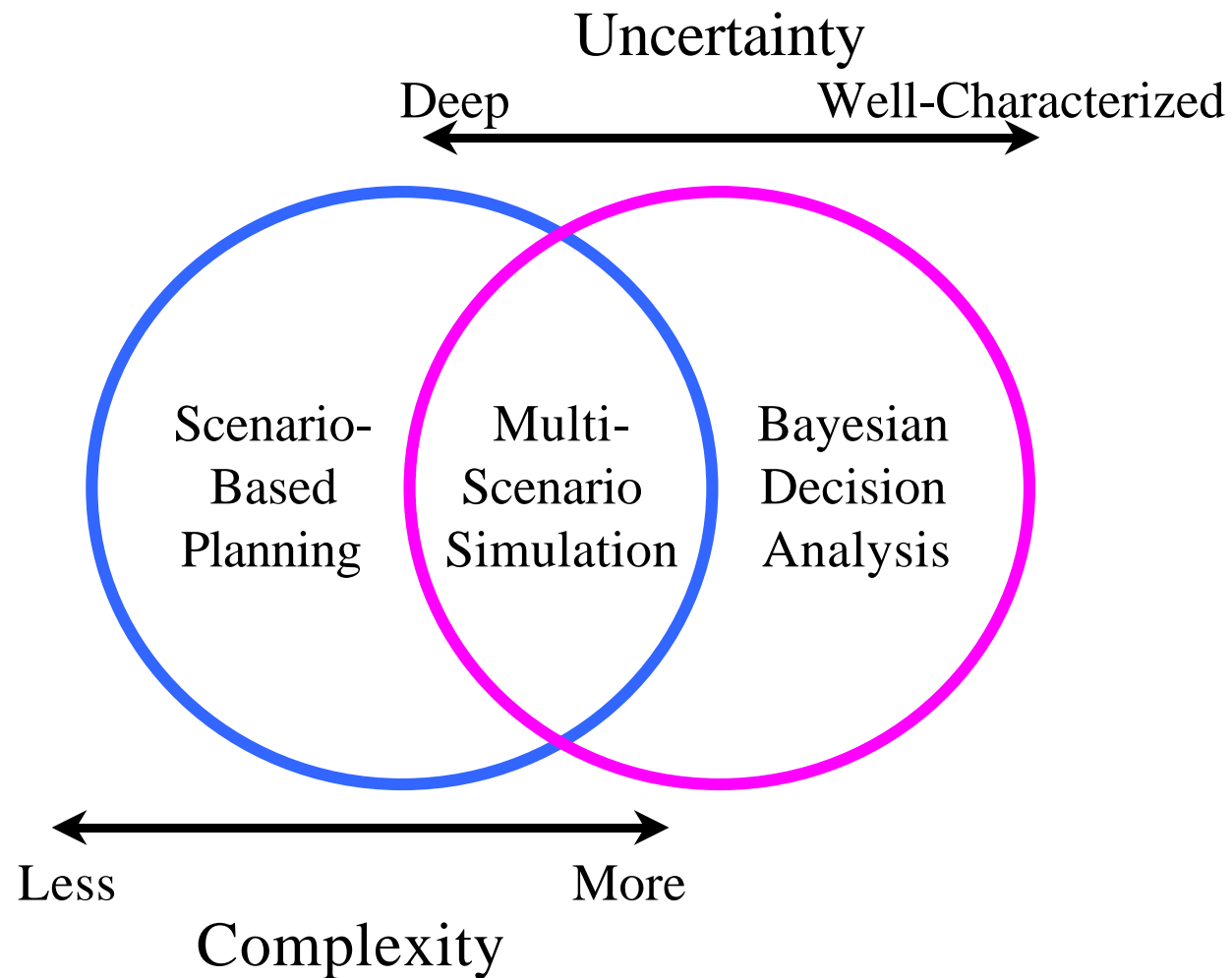
Often Look for Robust Strategies

Robust strategies:

- Work reasonably well, at least compared to alternatives, across a wide range of plausible scenarios
- Are often adaptive, that is, evolve over time in response to new information
- May help build consensus because stakeholders can agree on a strategy without agreeing on what will happen in the future

Multi-Scenario Simulation

Particularly Useful for Complex Systems



Outline

- Agent-based model of technology diffusion
- Multi-scenario simulation analysis
- Policy Implications

How Should Climate Policy Help Promote Innovation?

- Near-term emissions reductions serve two purposes
 - Reduce the amount of carbon in the atmosphere
 - Reduce the cost of future emission reductions
- Given deep uncertainty, in the near-term should policy-makers focus on
 - Getting the prices right (e.g. emissions trading, carbon taxes)?
 - Technology policies (e.g. subsidies, tax credits)?
 - Some combination?

Approach

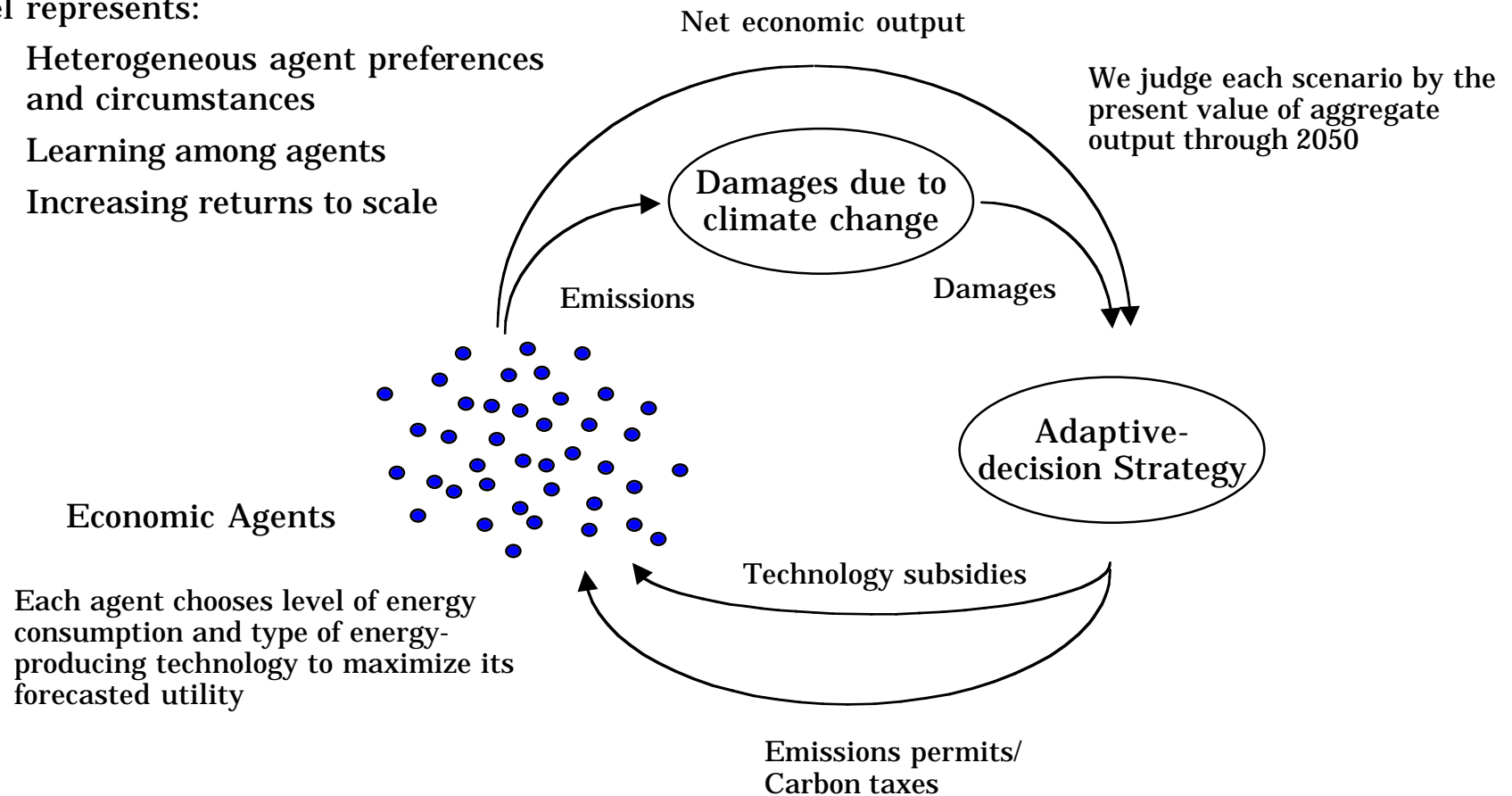
- Use agent-based model of technology diffusion to capture key factors
 - Increasing returns to scale
 - Imperfect information
 - Heterogeneous technology preferences among economic actors

- Compare the performance of adaptive-decisions strategies against a wide range of plausible futures. Strategies include:
 - Price instruments only
 - Technology subsidies only
 - Combined strategy

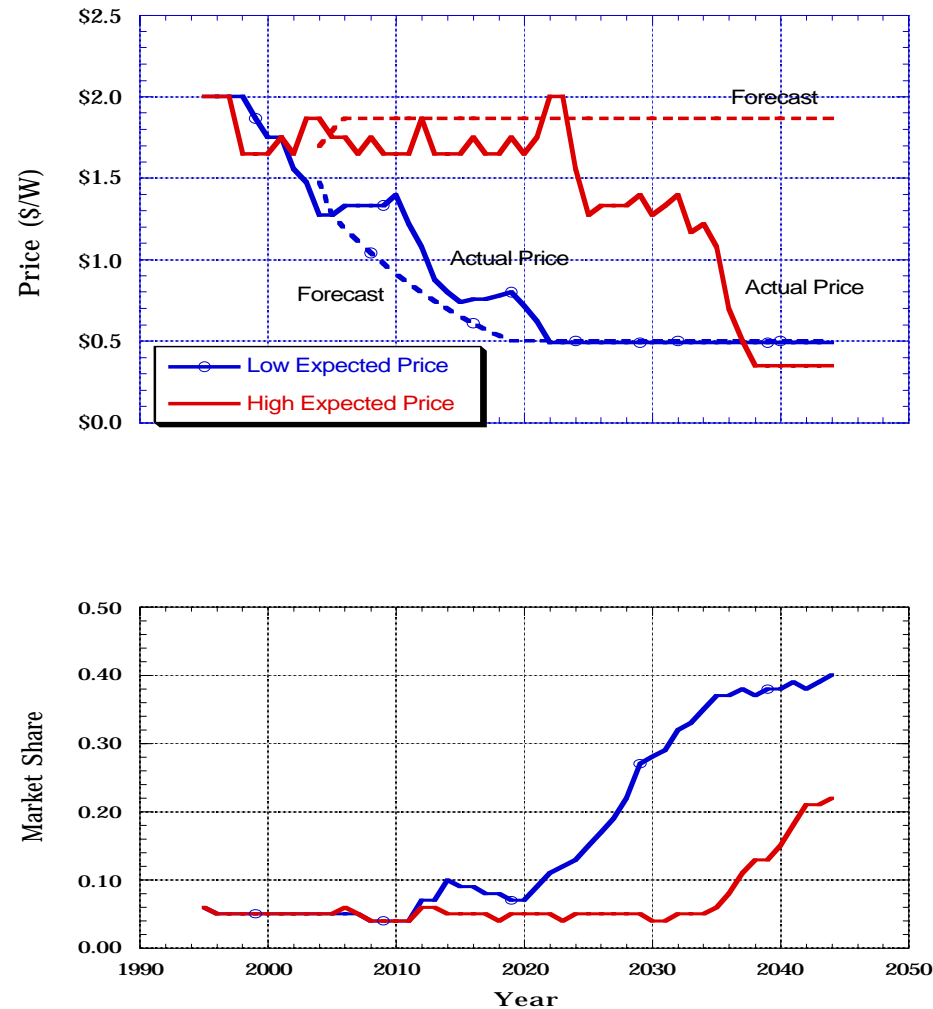
Agent Model Treats Externalities Important to Technology Diffusion

Model represents:

- Heterogeneous agent preferences and circumstances
- Learning among agents
- Increasing returns to scale



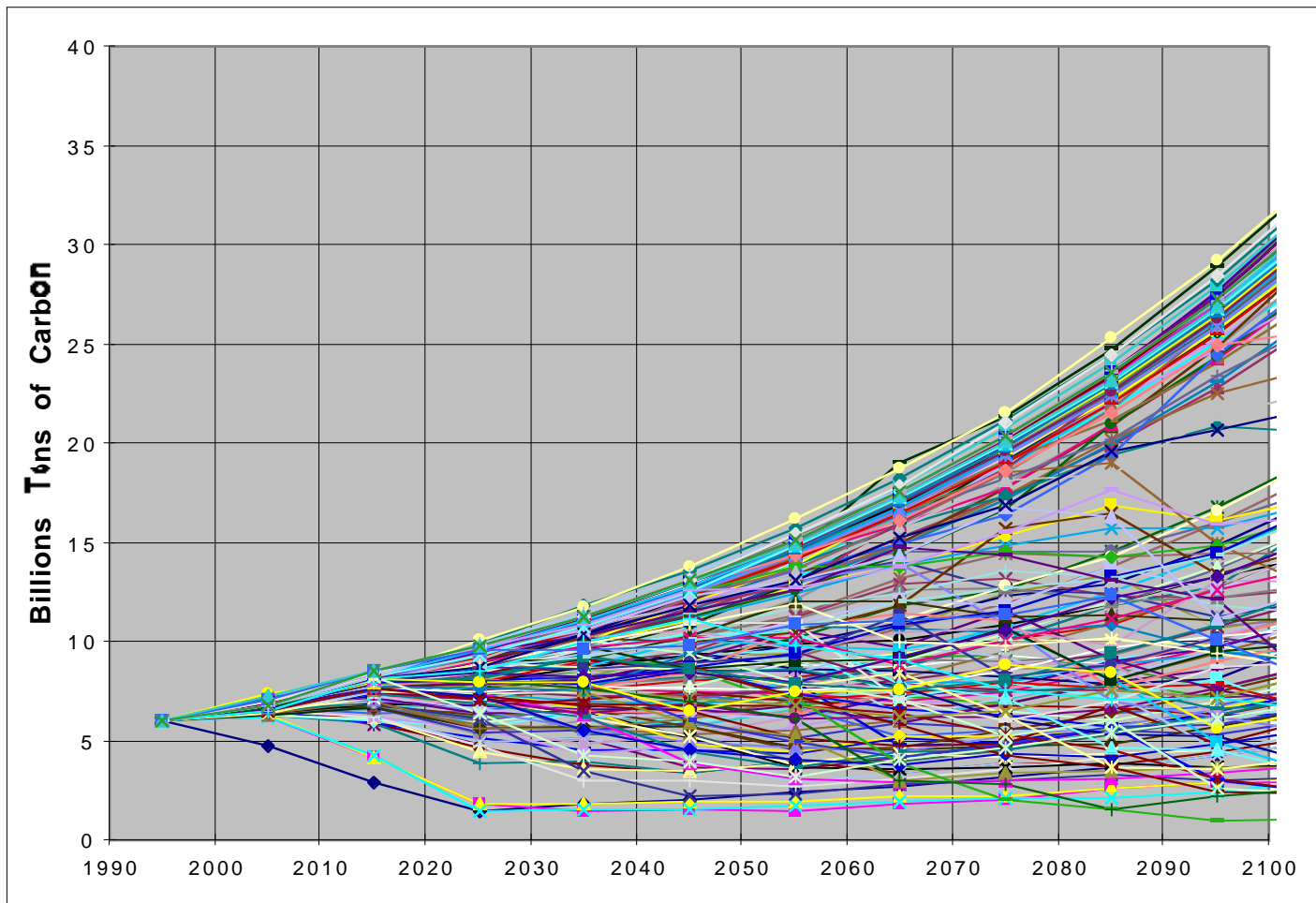
With Increasing Returns, Early Expectations Can Influence Future Market Share



Outline

- Agent-based model of technology diffusion
- Multi-scenario simulation analysis
- Policy Implications

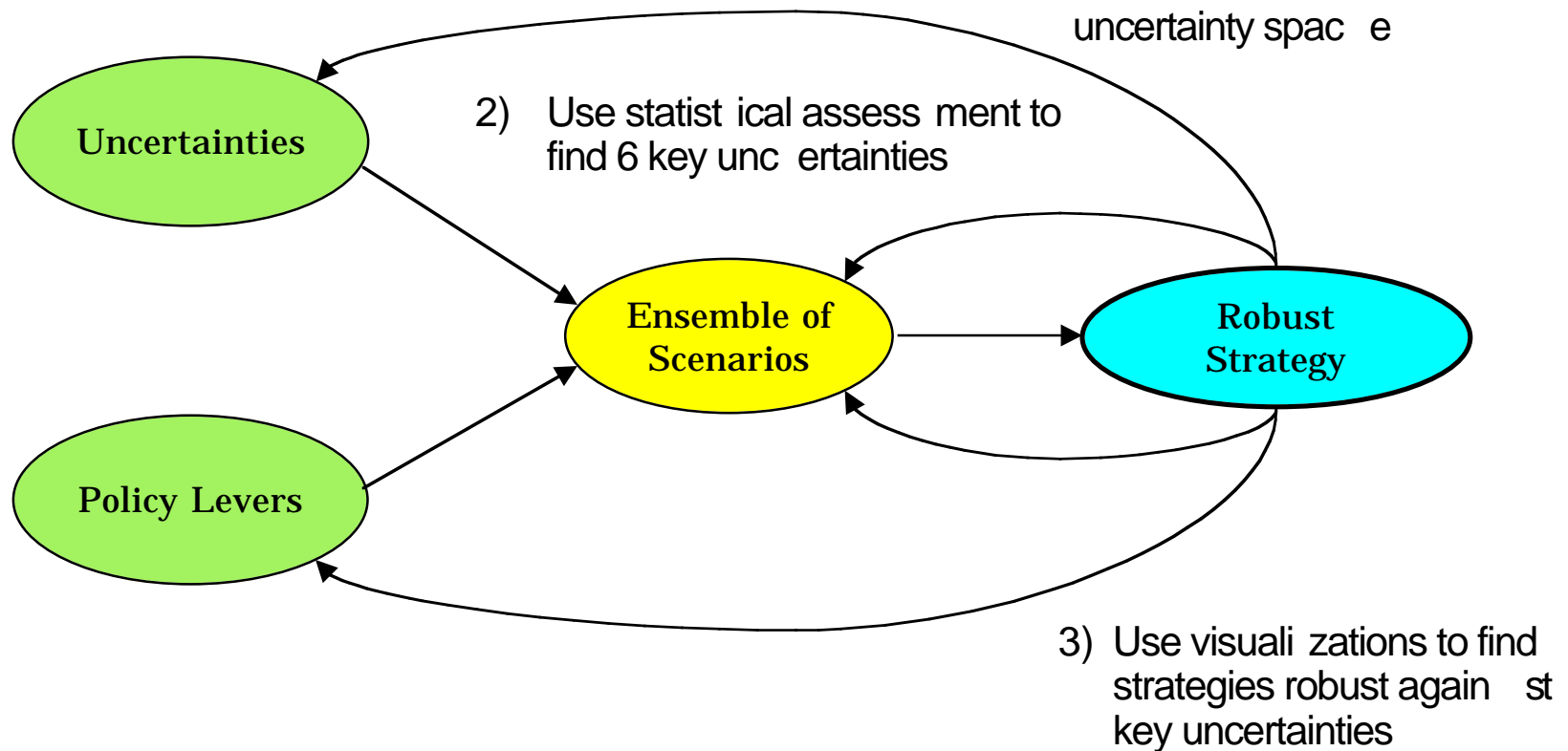
The Past is Consistent with Many Futures



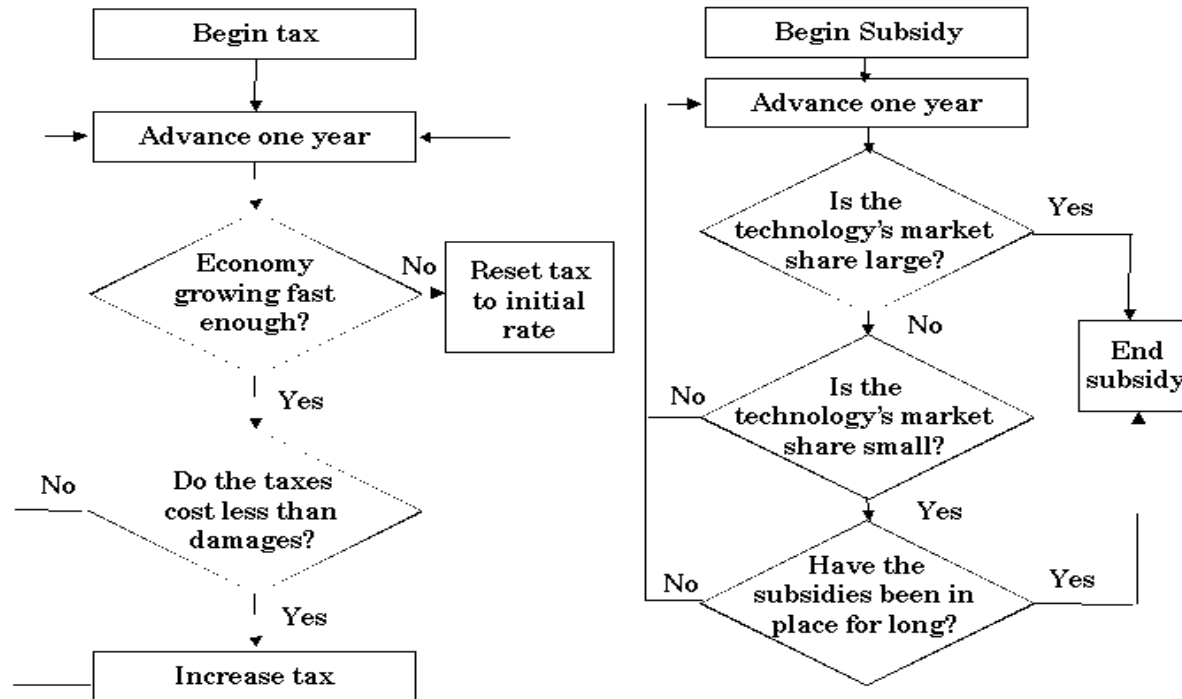
Implementing Multi-Scenario Simulation

1) Search to generate futures (1,600) consistent with available data

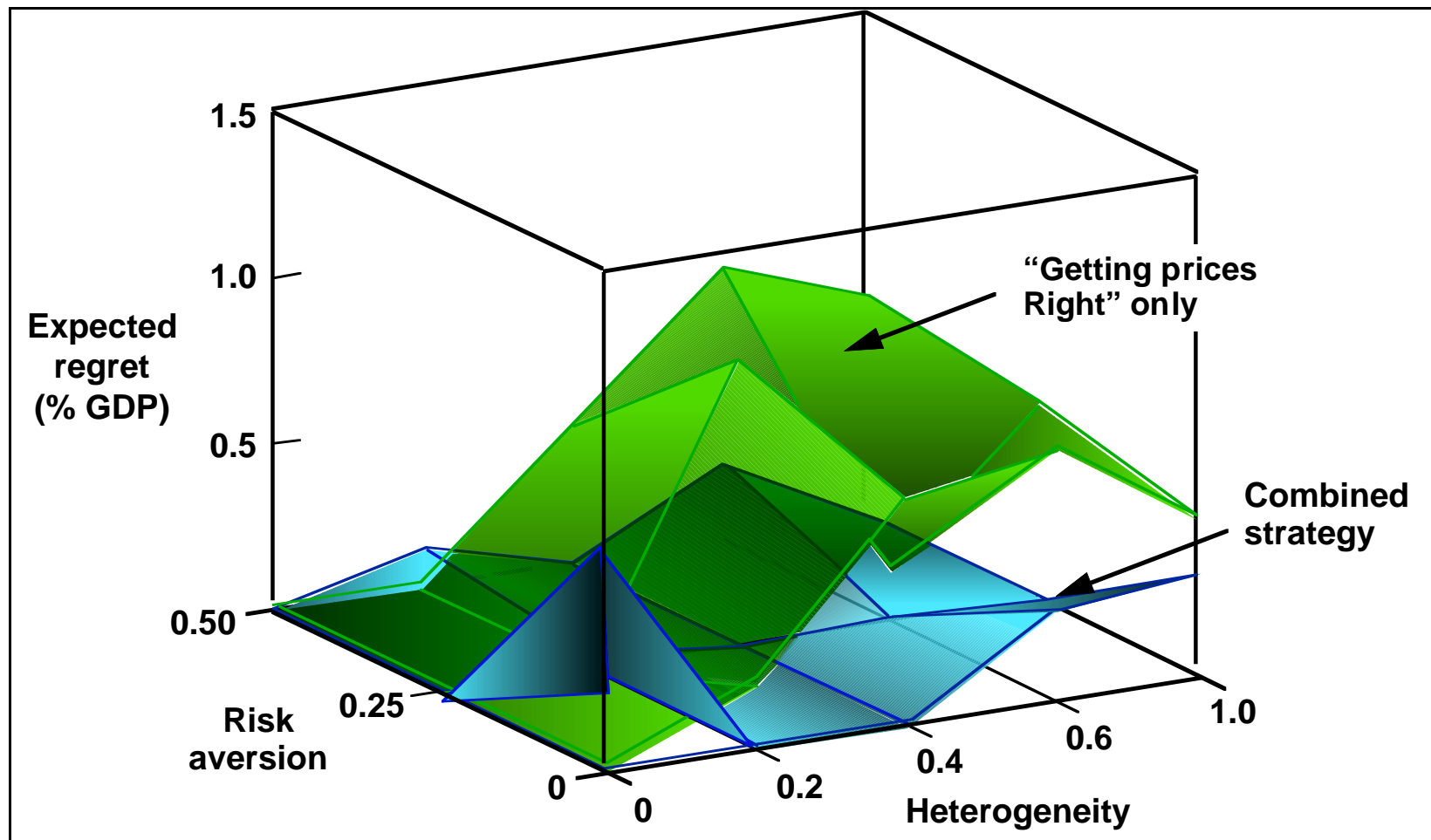
4) Test hypotheses with back search over other dimensions of uncertainty space



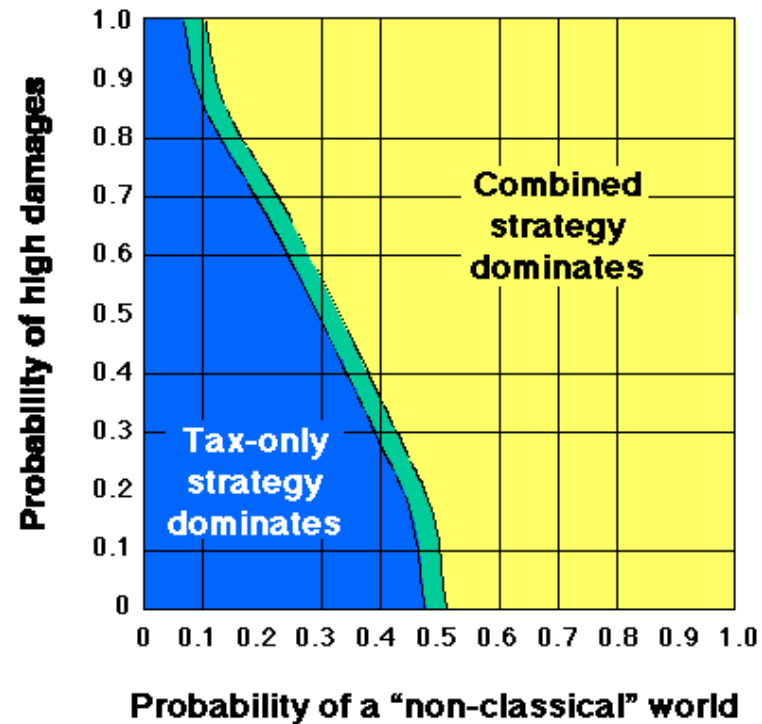
Adaptive Carbon Tax and Technology Incentives



Combined Strategy Dominates If Heterogeneity is Important



Combined Strategy Dominates for Modest Expectations about Damages and Diffusion

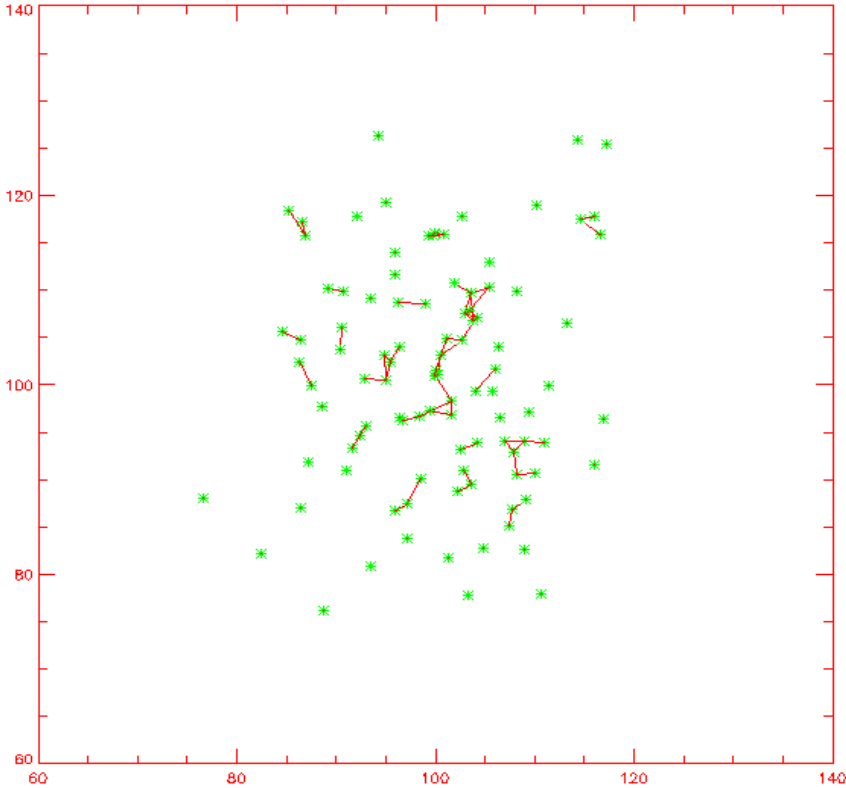


New Features of Model

- Tradable permits replace carbon taxes
- Agents learn about technology performance via networks rather than random sampling

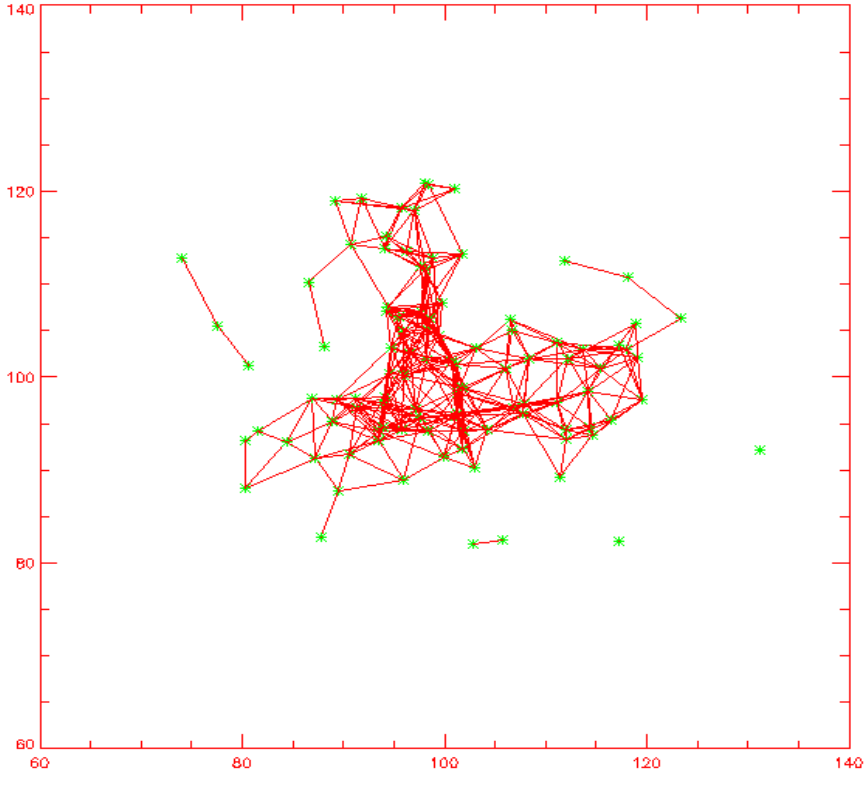
Information Flows Can Differ By Region

LCD



Low Connectivity

OECD



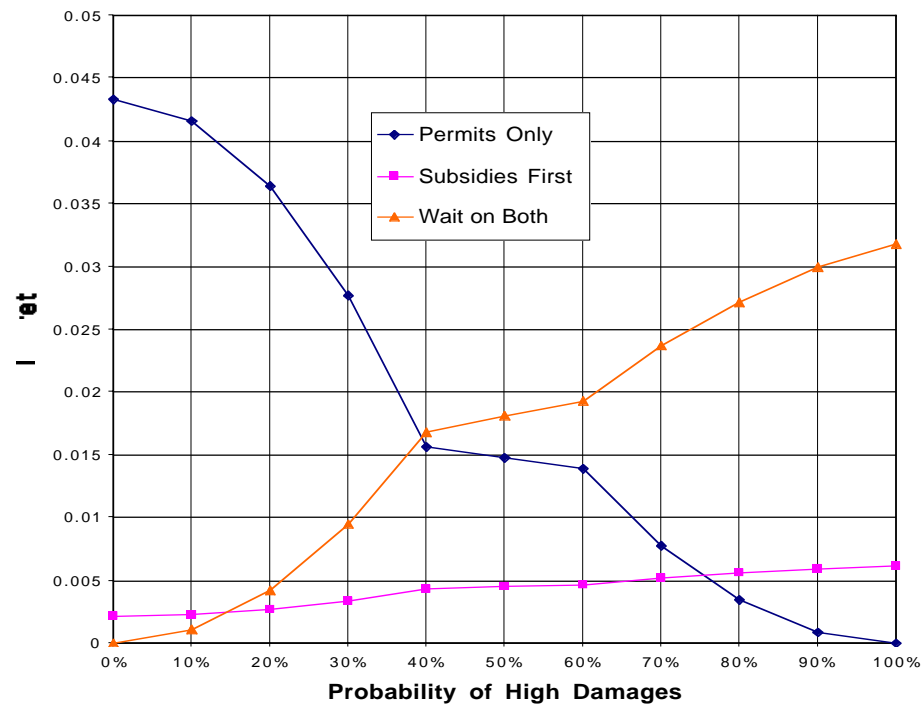
High Connectivity

What Timing of Policy Actions is Robust?

Compare:

- Emissions trading starting now
- Technology incentives now with trading later if needed
- Implement both trading and technology incentives later if needed

Robust Policies May Delay Permits, but not Technology Incentives



Outline

- Agent-based model of technology diffusion
- Multi-scenario simulation analysis
- Policy Implications

Are Current Policies Robust?

- Framework Convention on Climate Change could be robust, but currently
 - Too much emphasis on emissions reduction targets
 - Too little emphasis on technology development, institution building, and agreement on triggering observations
- *In the near-term, policy should focus on early adopters rather than impose costs on everybody*
- *Main purpose of emissions trading in the near-term may be practice, rather than emissions reductions*
- *Need better indicators to measure success of climate policies*

Methodological Observations

Multi-scenario simulation methods:

- Can help assess policy choices under conditions of deep uncertainty
 - Computer-supported inductive reasoning can combine scenario-planning with quantitative decision analysis
- Can identify and assess robust, adaptive-decision strategies
- May be particularly useful for policy applications of complex systems models