Reciprocal Problem

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- Characterization of uncertainty needs to be informed by the use of the information – e.g. what decisions will be made on the information
- Users (decision-makers) need to know about how uncertain the consequences of their decisions are, and how different decisions change rewards and uncertainty of rewards

Representing Uncertainty for Business and Regulatory Decisions

- Mississippi Power need for new generation resources
  - Choice between natural gas and IGCC with CCS (Kemper)
  - Key uncertainties determined to be natural gas prices and climate policies
  - Evaluation of alternatives based on 16 scenarios
    - 4 natural gas x 4 climate policy
- Decision criterion
  - Production cost models characterized rate impacts (change in revenue requirement) of each alternative under each scenario
  - Minimize rate increase

Controversy and Decisions

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- Results
  - Presented in a matrix showing in each cell the generation choice that provided smallest rate increase (lowest cost)
  - Kemper winner in 12 - 15 of 16 cells (depending on method of calculating rate impact)
- Controversy
  - Did the scenarios include a wide enough range of natural gas prices?
    - Resulted in Order to add a lower gas price scenario so that Kemper was more costly than alternatives in in 5 - 8 out of 20 cells
  - What if construction costs exceed company estimates?
    - 20% cost increase would make Kemper more costly than alternatives in 16 out of 20 cells

Evaluation of the Process

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- At first, increased understanding of how uncertain outcomes of any decision would be
  - Possible range of impacts on ratepayers
  - Whether effects of natural gas price uncertainty could be reduced
  - Who should bear construction cost risks
- Eventually, understanding the decision criterion led to gaming
  - Criterion devolved to “box counting”
  - Leading to manipulation of scenario definitions (uncertainties) to create boxes supporting particular interests
- Outcome – realization there is no dominant solution and the regulators need to decide who bears the risks

What Got Us to Box Counting

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- Management attitude toward risk
  - "No regrets" criterion ➔ "create payoff matrix and pray for dominance"
- Unwillingness to assign probabilities
  - Disagreement among stakeholders about distributions
  - Attitude toward risk
  - Nature of uncertainties – climate policy dimension
- Lack of experience in dealing with uncertainty
  - Understanding of the nature and magnitude of uncertainties about inputs
  - Comfort with making decisions with potential regrets
  - Preference for intuitive versus explicit decision criteria after seeing uncertainties (e.g. minimax-regret)

Getting Past Box Counting

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- Assign probabilities
  - Elicitation of probabilities on scenarios works (sometimes)
  - By whom?
    - Experts
    - Management
    - Wider stakeholder groups
  - On what?
    - Scenarios (natural gas prices, carbon price)
    - Fundamentals behind scenarios
- Choose result that will determine decisions (impact on rates) and how it will be calculated
- Translate probabilities of scenarios into probabilities of outcomes (rates) under different decisions
  - Set of CDFs for decision criterion for different decisions works well
  - Stochastic dominance
  - Mean and variance of outcomes

Implications for Climate Modeling Uncertainty

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- Start with the decision – why are we doing this?
  - Recognize where controversy arises in making decisions
- Determine what endogenous variables are most relevant to decisions
  - May not be the same for all stakeholders or decisions, but can focus next steps
- Assign ranges to parameters or assumptions to which model is known to be sensitive
- Combine into scenarios that will illustrate sensitivity of relevant endogenous variables to uncertainties
- Portray uncertainty of outcomes of different decisions

Explaining Consequences of Decisions

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- In business and regulatory decisions, the key insight needed is into the consequences of different decisions
- The unpleasant facts to be communicated are that
  - There are potential regrets to every decision
  - Choosing involves accepting risk
- Example:
  - Climate impacts on U.S. in BAU could be in range (+a%, -b%) of GDP with p% probability *or* a cdf of % changes in GDP or EV
  - Net costs of an %X carbon tax could be in range (+m%, –n%) with p% probability or a cdf
- Next step – how to make decisions in light of these facts