Background on Economy Wide Modeling at EPA

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National Center for Environmental Economics

U.S. Environmental Protection Agency

Outline

1. Regulatory Context and Choice of Analytic Model
2. Previous SAB Engagement on CGE Modeling
3. Development of CGE Model for Regulatory Analysis

Regulatory Context

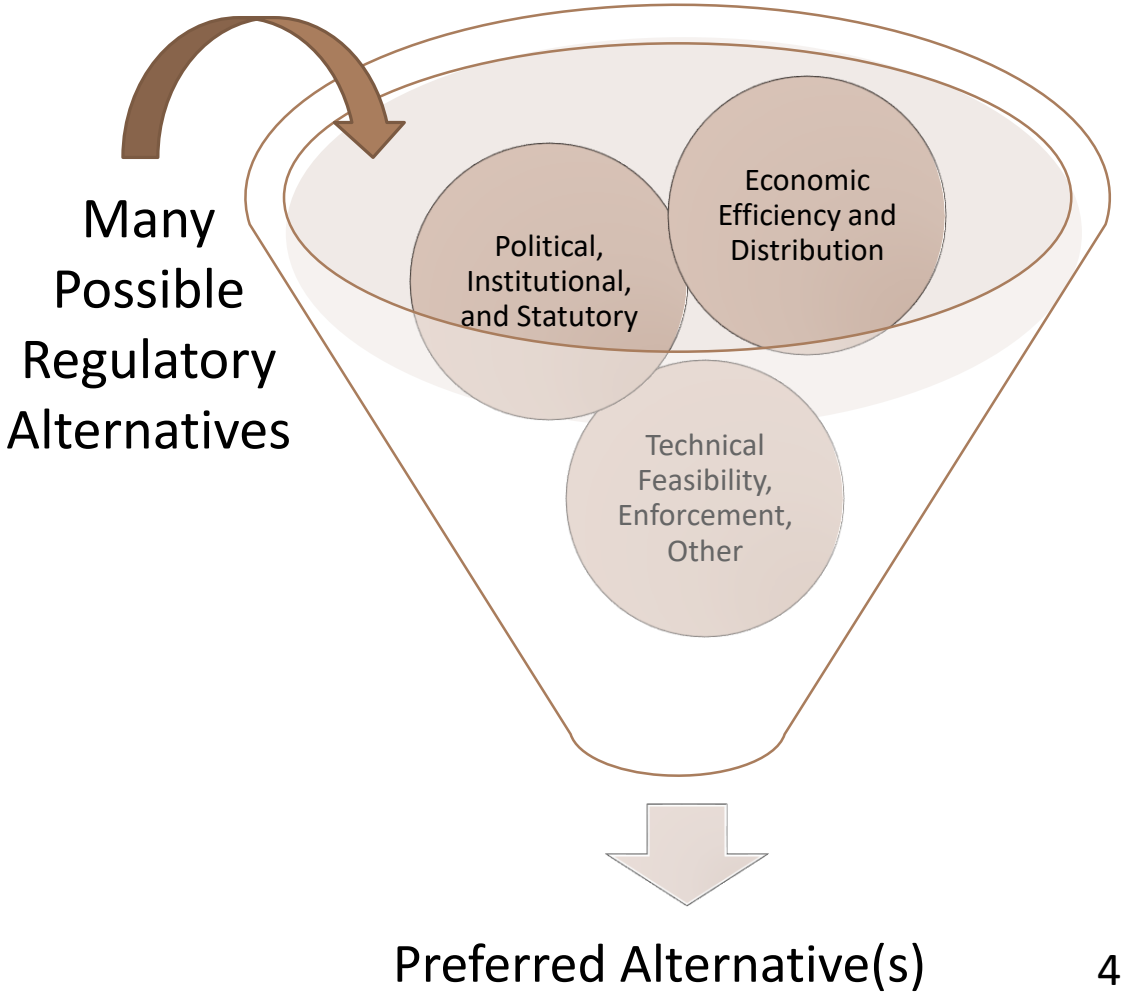
- Economic analysis can inform policy decision (as allowed by statute) and the public through:

- Benefit-cost analysis to evaluate favorable effects of policy actions (social benefits) relative to its total burden (social costs)
  - Conduct BCA for all regulations expected to have $100 million or more in costs or benefits in any single year

- Economic impact analysis to evaluate how benefits and costs are distributed among different households and sectors of the economy

Economic Analysis is One of Many Decision Criteria

- Political Factors
- Statutory Instruction
- Institutional Feasibility
- Technical Feasibility
- Benefits and Costs (Economic Efficiency)
- Enforceability
- Distributional Concerns
  - Economic Impacts
  - Environmental Justice
- Ethics
- Sustainability



Regulatory Context

- EPA analyses typically focus on the directly regulated sector
  - Sometimes closely related sectors are included if price changes expected
  - E.g., natural gas and coal sectors for electricity sector regulations
- For most regulations this captures majority of impacts
- Sometimes changes in the regulated sector affect many other sectors
  - E.g., changes in electricity prices affect nearly all other firms

EPA Regulations Vary Widely

Attribute	Key Questions that Inform Analysis of Costs
Form of the standard	Is it an emission rate, technology, or product standard? Are limits applied at a sub-facility or facility level? Is trading/crediting allowed? Is it differentiated along particular attributes (e.g., age, plant or unit type, fuel, location)?
Methods of compliance	Are methods of compliance clearly identified? Is it expected that methods of compliance will vary across units, firms, sectors, locations?
Regulated sources	Is regulated universe readily identified? In which sector(s) are directly affected sources? How easy is it to map regulated sources to sectors?
Unit compliance costs	Are estimates of unit compliance costs available? Is decomposition of compliance costs by input available? Are some components of costs more uncertain or not available? Are some methods of compliance expected to result in process change?
Aggregate compliance costs	What is the expected magnitude of aggregate compliance costs? How does it compare to the size of the regulated sector?
Implementation	Is implementation defined directly in the regulation or are key aspects left to the states or other government entities? What is time period over which compliance occurs?

Choice of Analytic Model(s)

- Many factors affect which analytic tools are most appropriate for a given regulatory analysis
- EPA *Guidelines on Preparing Economic Analysis* find that CGE analysis can add value:

For "policies that have large economy-wide impacts, especially when indirect and interaction effects are expected to be significant …[and] generally more appropriate for analyzing medium- or long-term effects of policies or regulations."

"[A]s the number of affected markets grows, it becomes less and less likely that partial equilibrium analysis can provide an accurate estimate of social cost. Similarly, it may not be possible to accurately model a large change in a single regulated market using partial equilibrium analysis."

Choice of Analytical Model(s)

- Choose model(s) for estimating costs to match the most salient aspects of their expected effects
- Depending on magnitude of costs and benefits and length of time for rule implementation, use one or more modeling approach:
  1. Engineering or model plant,
  2. Partial equilibrium (PE), or
  3. Computable general equilibrium (CGE) modeling

Choice of Analytical Models

- Engineering and model plant approaches are used when few directly regulated sectors are expected to be affected with minimal effects on price or quantity
- Detailed PE models are used (when available) when impacts are limited to a few sectors but behavioral changes may result in price, quantity, quality, product mix, or productivity changes
- When changes in behavior are expected to result in effects in many markets, may use CGE models
  - EPA's use of CGE models for regulatory analysis limited to-date

History of Engagement with SAB

- Given limited use of CGE models in regulatory analysis, EPA engaged SAB to consider technical merits and challenges of prospectively evaluating costs, benefits, and economic impacts of environmental regulations using these tools

- SAB issued final report with recommendations on how EPA can use CGE models to inform regulatory analysis in Sept. 2017

SAB: CGE Models in Regulatory Analysis

- CGE models can aid in the EPA's analysis of regulations as a complement to tools currently used

> *"The SAB recommends that the EPA ... integrate economy-wide modeling, and computable general equilibrium modeling in particular, into regulatory analysis in order to offer a more comprehensive assessment of the benefits and costs"*
>
> *"GE modeling should be considered only as a supplement to the agency's current practices, not as a replacement"*

- SAB did not identify bright line on use of CGE models based on magnitude of abatement costs
- CGE models can capture important interactions between markets, missed by PE analysis, when there are *both* significant cross-price effects, and significant distortions in those other markets

SAB : CGE Models in Regulatory Analysis

- Inability of a model to capture interactions between costs and benefits does not invalidate use of CGE model to estimate costs
- CGE models may offer insights into ways costs are distributed across regions, sectors, or households
- Data availability is important challenge for modeling some regulations
  - Data limitations may be a significant obstacle to achieving granularity needed to adequately represent some regulations that fall on narrow segments of the economy
  - Advised not to try and build that granularity into the CGE model, but to focus on linking a GE model to a more detailed PE model of the regulated sector
- Sensitivity analysis around key assumptions, parameter, and functional forms is warranted

SAB Advice: Capacity Development

- Recognized need for EPA to balance analytic needs with resource limitations

> *"[T]he SAB recommends that EPA develop, over a period of time, a suite of [GE] models that are adapted to different regulatory needs"*
>
> *"It will rarely be appropriate to build a new model for analysis of a single regulation. Rather, EPA should focus on models that will be flexible enough to be used for multiple applications, or that can be linked to regulation-specific PE sectoral models."*

- Emphasized transparency in use and development of CGE models
  - Open source models that are well documented
  - Focus on CGE models with "modest degree of detail" that can be linked to detailed PE models when needed

EPA's Response to SAB

- CGE models have potential as "a powerful analytic tool to evaluate major regulatory efforts and tailor them to avoid unintended and potentially burdensome consequences for the economy."

- To ensure that CGE models are appropriately leveraged in future regulatory analyses, NCEE tasked with leading EPA's efforts to develop economy-wide modeling capabilities

- Centralized development of CGE modeling
  - Greater quality control and consistency in analyses
  - Minimize duplicative modeling efforts across offices
  - Increase transparency of CGE analyses for general public and key stakeholders

Developing CGE for Regulatory Analysis

- As we undertake CGE capacity building at EPA, mindful that:
- CGE models represent highly aggregate version of the economy, so need to be strategic when designing a CGE model for use in a regulatory context
- Regulations not like taxes
  - Not simply wedge between unregulated and regulated market price; regulations can be quite complicated
  - Effect of EPA regulations are small relative to the size of U.S. economy
  - Challenging to represent some factors that affect costs (e.g., process change, extrapolated cost)
- Detailed engineering or PE compliance cost estimates are required inputs
  - Quality of inputs affects quality of model outputs
  - Uncertainty in inputs warrants consideration in the analyses

Development of SAGE Model

- As part of efforts to develop capabilities, EPA built new CGE modeling framework named SAGE
  - SAGE is a recursive acronym, as in SAGE is an Applied General Equilibrium model
  - Dynamic CGE model of U.S. economy with modest spatial, sectoral, and household detail
- Foundation to provide consistency across regulatory CGE analyses
  - Designed as a flexible framework that can be modified within specific regulatory contexts
- Initial milestone in long-term commitment to developing capacity
  - Planned improvements in framework over time
  - Access to additional CGE models may be retained or acquired as necessary for the EPA's analytic needs
- Linking CGE model with detailed sector models is a research priority, but efforts to explore explicit linking with SAGE is still exploratory