Economic Assessment for Climate Action in California

Overview of the BEAR Model

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Why use an economic model?

- Most human-induced environmental change originates in economic activity.
- Environmental effects of policy will largely result from economic responses.
- Thus, to understand environmental incidence, we need to understand economic behavior.
Why a state model?

1. California is unique
   • Both economic structure and emissions patterns differ from national averages
2. California needs research capacity to support its own policies
   • A first-tier world economy
3. California stakeholders need more accurate information about the adjustment process
   • National and global assessments mask extensive interstate and regional spillovers and trade-offs
Why use a general equilibrium model?

1. **Complexity** - Given the complexity of today’s economy, policy makers relying on intuition and rules-of-thumb alone are assuming substantial risks.

2. **Linkage** - Indirect effects of policies often outweigh direct effects.

3. **Political sustainability** - Economic policy may be made from the top down, but political consequences are often felt from the bottom up.

GE models, supported by detailed data, can elucidate these linkages and improve visibility for policy makers.
Model Structure

Three Components: Data, Model, Scenarios

1. Detailed economic and emissions data
   - Three activity aggregations: 165, 50, and 10 sectors/commodities
   - 10 household groups (by tax bracket)
   - Detailed fiscal accounts
   - 14 emission categories

1. Berkeley Energy And Resource (BEAR) Model – a dynamic GE forecasting model

2. Three Scenario Horizons – BEAR solves annually to 2020, 2050, and 2080
Climate Change and Carbon Fuel

GHG Gases
(CO2 equivalent shares)

Source: CEC

11 February 2007
Economy-Environment Linkage

Economic activity affects emissions in three ways:

1. *Growth* – uniform aggregate growth increases resource use
2. *Composition* – changing sectoral composition of economic activity can change aggregate pollution intensity
3. *Technology* – any activity can reduce its pollution intensity with technological change

All three components interact to determine the ultimate effect of the economy on environment.
How we Forecast

BEAR is being developed in four components.

Components:
1. Core GE model
2. Technology module
3. Electricity modeling
4. Transportation component
Detailed Methodology

National and International Initial Conditions, Trends, and External Shocks

Standards Trading Mechanisms Producer and Consumer Policies

California GE Model

Transport Sector

- Data

Prices Demand Sectoral Outputs Resource Use

Innovation: Production Consumer Demand

Detailed Emissions of CO2 and non-CO2

Detailed State Output, Trade, Employment, Income, Consumption, Govt. Balance Sheets

Energy Regulation RPS, CHP, PV

LBL Energy Balances PROSYM Initial Generation Data Engineering Estimates

Household and Commercial Vehicle Choice/Use

Fuel efficiency Incentives and taxes

Technology

Electricity Sector

- Results

- Policy Intervention

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CERES - UCB

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Specific Sectors

1. Most sectors are modeled in similar fashion, with detailed intermediate use, labor, capital, and energy value added.

2. A few emissions intensive sectors are modeled differently to take account of their particular industry structure.
Electric Power

Distinctive features:
1. A portfolio of production technologies
2. Rigid output prices
3. Excess capacity

Modeling strategy:
1. Rigid prices, demand-driven market
2. Producers choose:
   1. Short run: capacity utilization rate
   2. Long run: Capacity (contracts, investment)
Electricity Sector

- Inputs/Factors
  - PG&E
  - SCE
  - SDGNE
  - Others

- Generation Assets
  - Natural Gas
  - Hydro
  - Wind
  - Coal
  - Nuclear
  - Solar
  - Geothermal
  - Other

- Output
- Emissions
  - Air
  - Water
  - Soil

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Generation Portfolio, 2005

- **California**
  - Nuclear: 15%
  - Hydro: 19%
  - Coal: 20%
  - Geothermal: 5%
  - Wind: 2%
  - Solar: 0%

- **National**
  - Nuclear: 19%
  - Nat Gas & Oil: 22%
  - Hydro: 7%
  - Renewables: 2%
  - Coal: 50%

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Oil Refining and Cement

Plant 1

Plant 2

Plant 12

Inputs
Factors
- Labor
- Capital
- Fuels
- Resources

Output

Emissions
- Air
- Water
- Soil
Transportation Demand

- The transport sector accounts for over 40% of California CO2 emissions.
- To elucidate the path to our emission goals, patterns of vehicle use and adoption need to be better understood.
- We are currently with demand systems that take explicit account of public/private modal choice and a larger universe of vehicle alternatives.
Transport Choice

Households

Firms

Private Modes
- Air
- Water
- Heavy Truck
- Light Truck

Car 1
Car 2
Car n

Public Modes
- Bus
- Rail
- Water

Emissions
- Air
- Water
- Soil
Modeling Cap and Trade

1. BEAR models emissions endogenously, in proportion to energy use (or other process emission) by energy source.

2. This permits detailed sectoral estimation of tradable emission rights schemes (Cap and Trade).

3. All major program characteristics, such as coverage, allocation rules, offsets, and safety valves, can be modeled on a sector by sector, annual basis.
Cap and Trade Target Sectors
(from the 50 Sector BEAR aggregation)

• **Group 1: First Tier Emitters**
  A04DistElc  Electricity Suppliers
  A17OilRef  Oil and Gas Refineries
  A20Cement

• **Group 2: Second Tier Emitters**
  A01Agric  Agriculture
  A12Constr  Transport Infrastructure
  A15WoodPlp  Wood, Pulp, and Paper
  A18Chemicl  Chemicals
  A21Metal  Metal Manufacture and Fab.
  A22Aluminm  Aluminium Production

• **Group 3: Other Industry Emitters**
  A02Cattle  Cattle Production
  A03Dairy  Dairy Production
  A04Forest  Forestry, Fishery, Mining, Quarrying
  A05OilGas  Oil and Gas Extraction
  A06OthPrim  Other Primary Activities
  A07DistElec  Generation and Distribution of Electricity
  A08DistGas  Natural Gas Distribution
  A09DistOth  Water, Sewage, Steam
  A10ConRes  Residential Construction
  A11ConNRes  Non-Residential Construction
  A13FoodPrc  Food Processing
  A14TxtAprl  Textiles and Apparel
  A16PapPrnt  Printing and Publishing
  A19Pharma  Pharmaceuticals
  A23Machnry  General Machinery
  A24AirCon  Air Conditioner, Refrigerator, Manufacturing
  A25SemiCon  Semiconductors
  A26ElecApp  Electrical Appliances
  A27Autos  Automobiles and Light Trucks
  A28OthVeh  Other Vehicle Manufacturing
  A29AeroMfg  Aeroplane and Aerospace Manufacturing
  A30OthInd  Other Industry

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Modeling Standards

- Because of its detailed sectoral and household structure, BEAR can estimate the effects of a wide spectrum of standards programs.
- Both industrial product/process (e.g. RPS, PV) and household adoption/use (e.g. Pavley, appliance) standards can be modeled dynamically for detailed product categories.
Modeling Incentives and Fees

- Intertemporal schemes for adoption finance and other incentives and or fees can also be explicitly incorporated in BEARs dynamic framework, with annual accounting for adjustment costs and benefits.

- Detailed information about linkage and incidence effects reveals distributional effects and identifies
Modeling Innovation

• Innovation for energy efficiency has been the most growth-positive source of GHG mitigation potential for the California, both to reduce its own emissions and for leadership in global technology markets

• BEAR incorporates innovation explicitly scenario analysis, including investment costs and productivity/efficiency benefits, at the individual sectoral/product level and annually over time
Thank you