Perspectives on Public Administration: Applying Economics and Statistics to Climate Policy

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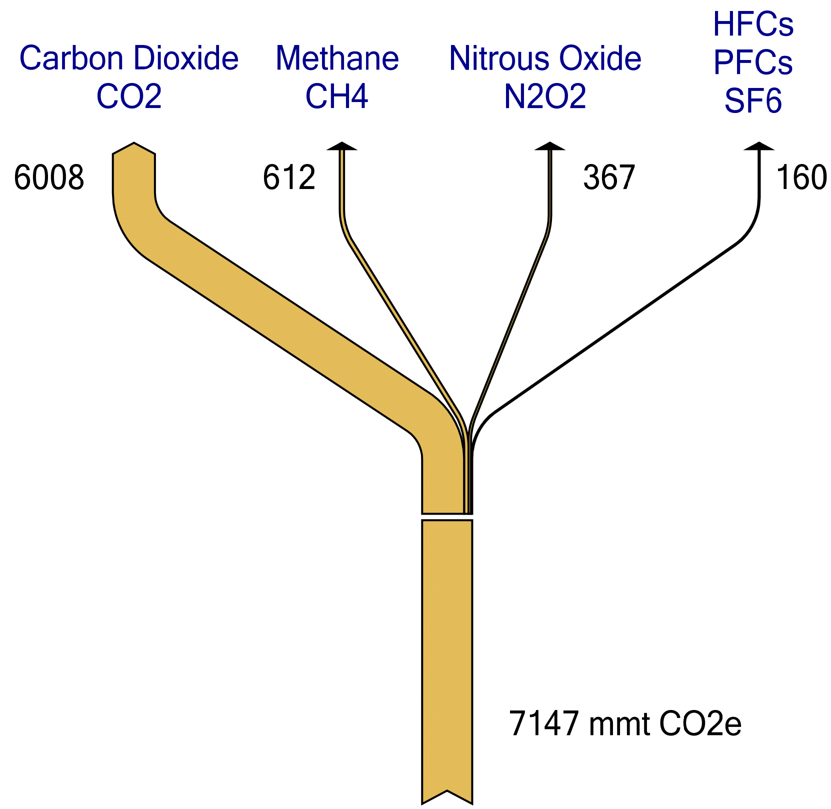
August 2010

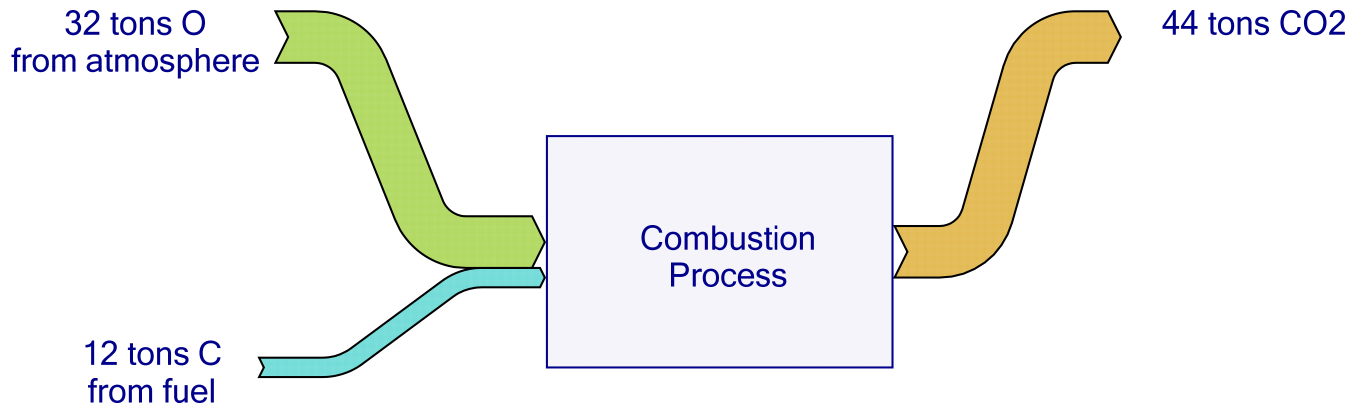
US greenhouse gas emissions in 2005

Weighted by effect on climate:

- 84% CO2
- 9% methane
- 5% nitrous oxide
- 2% other



CO2 originates from combustion



- Problem is fossil fuels
  - Net addition of carbon to the biosphere

- Fossil fuels vary in CO2 produced per unit of heat
  - Natural gas is lowest (best)
  - Petroleum is next
  - Coal is highest (worst)

Fuel use and energy units

- National fuel use is measured in quads
  - 1 quad = 1 quadrillion BTU (10^15)

- How large is a quad?
  - Coal "unit trains": 100 cars, about 1 mile long
  - 1 train fuels a 300 MW power plant for about 3 days
  - 1 quad = 4,500 unit trains

How much energy is used?

- World energy consumption
  - 400 quads per year
  - 1 quad every 22 hours
- US consumption
  - 100 quads
    - 86 quads from fossil fuels
    - 14 quads nuclear and renewables
  - 25% of world total
- US emissions
  - 6 billion tons of CO_2 or 1.7 billion tons of C
- In the long term, must make emissions 0
  - Reduce consumption or capture emissions

Reducing carbon dioxide emissions:

- Requires substantial investment by the private sector
  - More efficient vehicles
  - Better insulation and windows
  - Renewable energy
  - Additional nuclear plants
  - Carbon sequestration

- Policies must provide credible long-term incentives for investment

Key incentive: higher fossil fuel prices

- Shifts the fuel mix toward nuclear and renewables
  - Investments in power plants and vehicles
  - Give credits for sequestration

- Improves energy efficiency
  - Use less fuel to get equivalent outcomes
    - E.g., same thermostat setting but less fuel

- Reduced demand for fuel-intensive activities
  - Choosing different outcomes
    - E.g., different thermostat settings

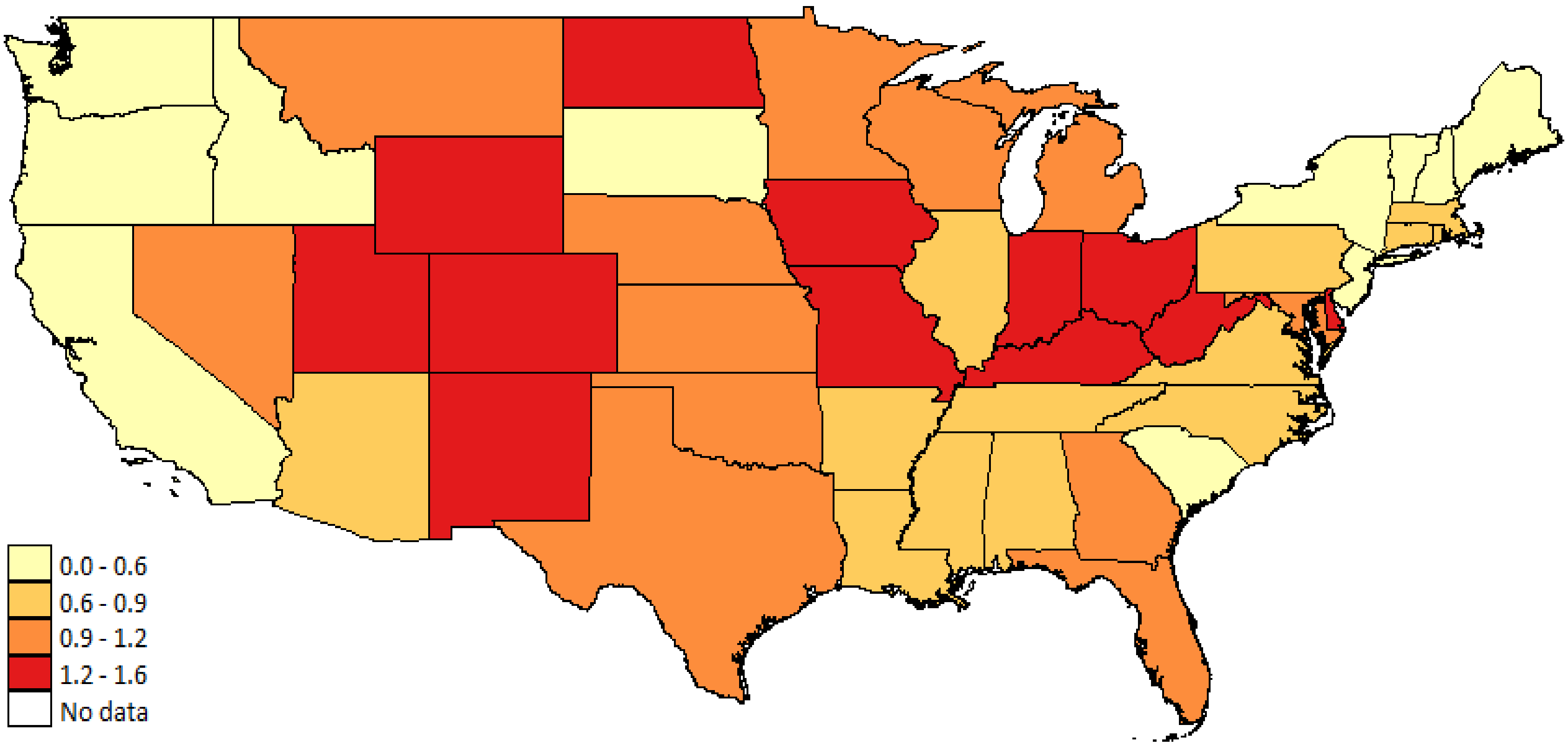
One option: a carbon tax

- Tax fossil fuels based on the CO_2 emitted
  - Example: $20 per ton of CO_2

- Raises prices of gasoline, natural gas and electricity
  - Gasoline: 17 cents per gallon
  - Natural gas: 110 cents per 1000 cubic feet
  - Electricity: 0 to 2 cents per kWh

  - In general, about an 8% increase

Cents per kWh due to a $15 CO2 fee

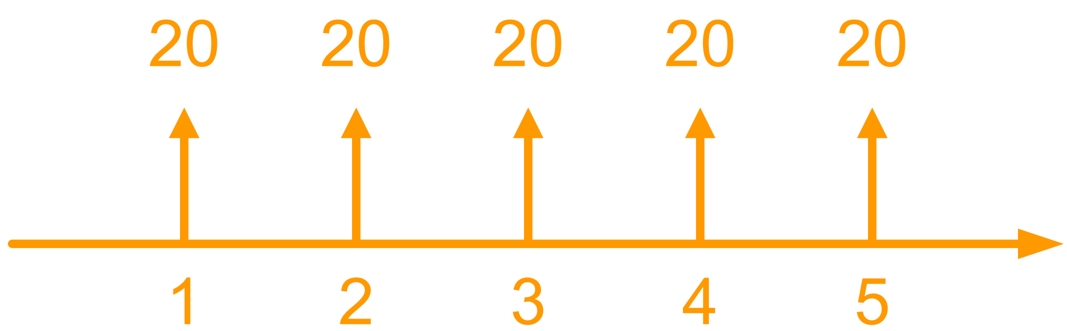


National average price is now about 9 cents per kWh

Emissions taxes and investment

- Example investment in new equipment
  - More efficient electric motor
  - One-time $300 payment
  - Eliminates 1 ton of carbon emissions every year
  - Saves $20 of emissions taxes per ton per year

- Cash flows:



Would be profitable:

- Payments without it
  - $20/year
- At a 5% interest rate ...
  - Present value of savings is $400
- Cost of motor
  - $300
- Gain from investment
  - $400 - $300 = $100

Importance of credibility

- Investors need to be confident policy won't be weakened

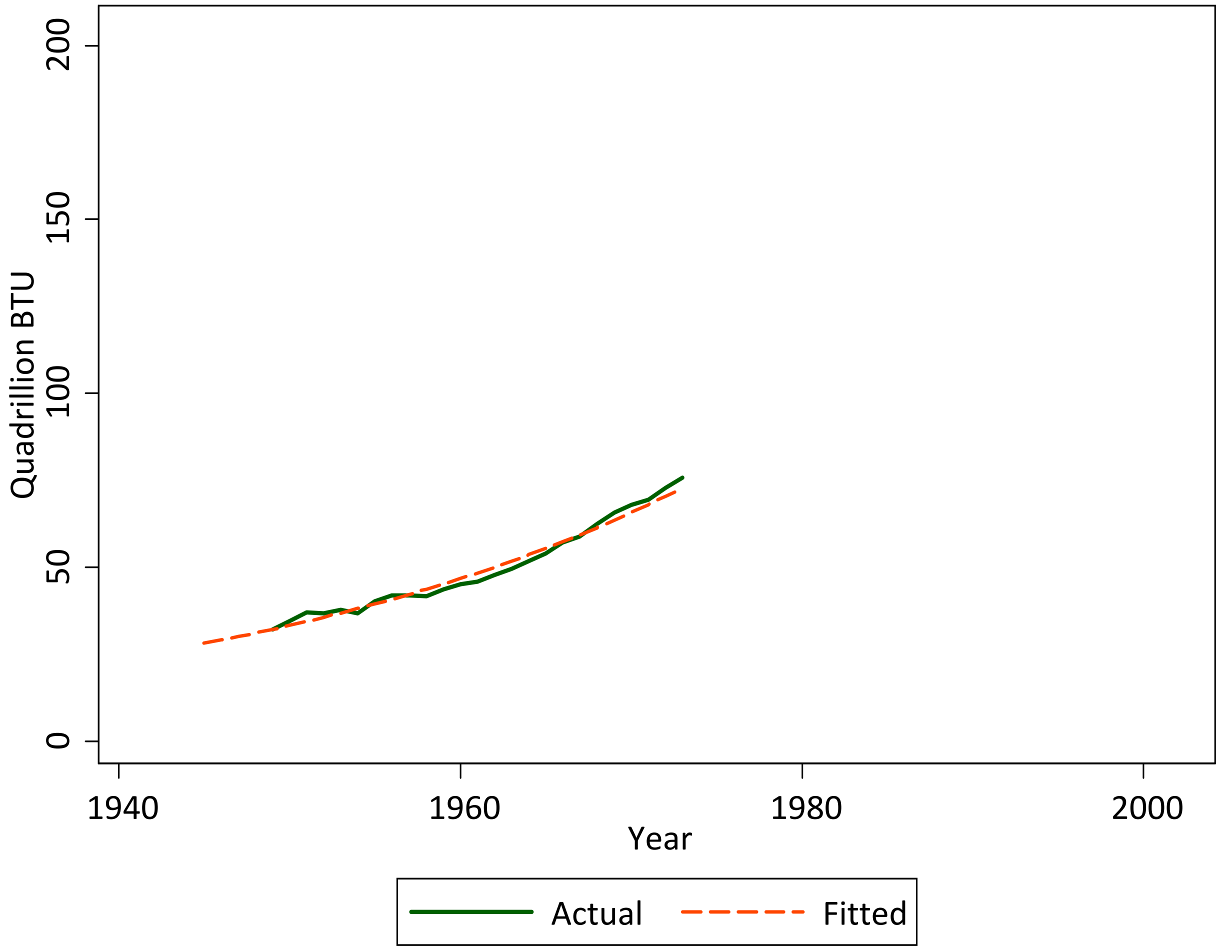
- If policy may be repealed:
  - Won't have to pay $20 per year for emissions
  - Expected savings < $20 per year
  - Expected value of savings < $400

- Example:
  - Suppose chance of repeal is 10% in each year
  - Value of investment drops to $133
  - Cost is still $300
  - Expected gain is now $133 - $300 = -$167
  - Loses money -- no incentive to invest

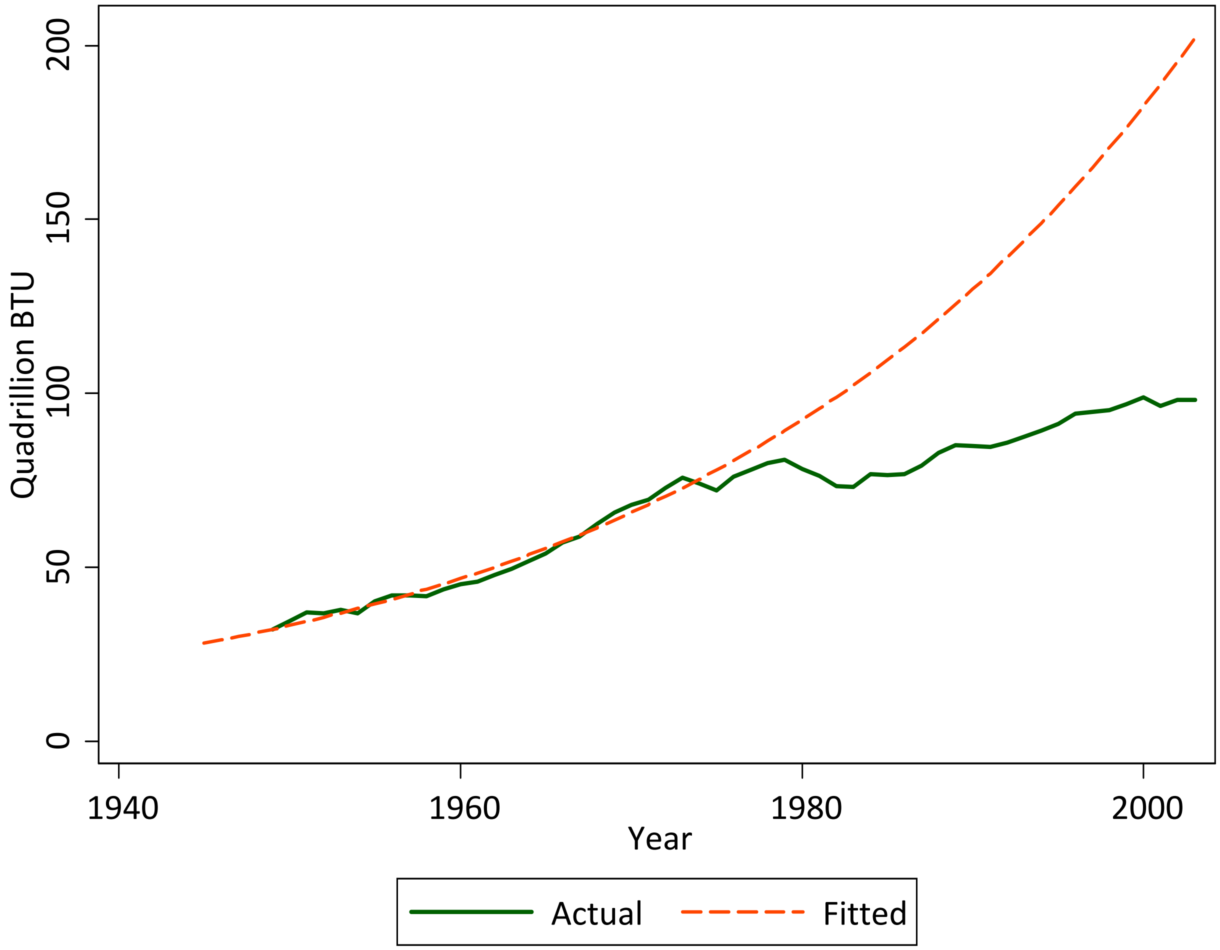
Are prices effective?

- What do we know from history about fuel use?

US fuel consumption after the war: 3.4% annual growth



Sharp change after the energy shocks!



Energy prices matter!

- Stabilized US energy consumption
  - Flat for about 20 years

- GDP growth was a little slower
  - About 0.2% per year: from 3.2% to 3.0%

Potential problems with a carbon tax

- Large energy taxes may not be politically viable
  - Not possible to discuss seriously

- Are large energy taxes credible?
  - Future governments could reduce or repeal them

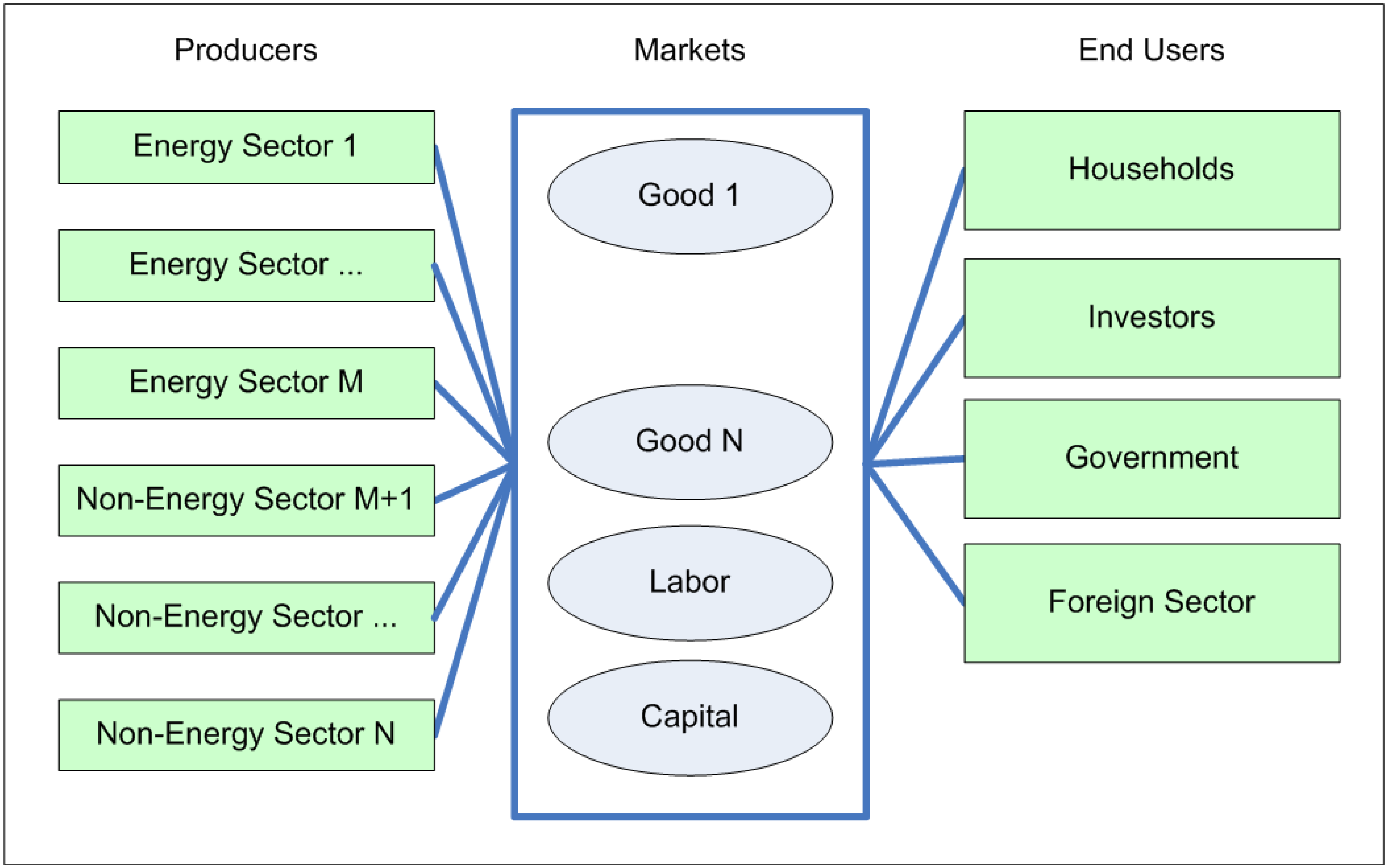
Looking forward, typical questions from policy makers

- How much would emissions fall for a given tax?
- How costly would it be in GDP?
- What would happen to energy producers?
  - Electric power producers? Oil and coal companies?
- What happens to energy users?
  - Aluminum producers? Airlines? Households?
- What about government finance?
  - Tax revenue? Government expenditures? The deficit?
- What does the policy do to investment and growth?
- What about exchange rates and international competition?
- ...

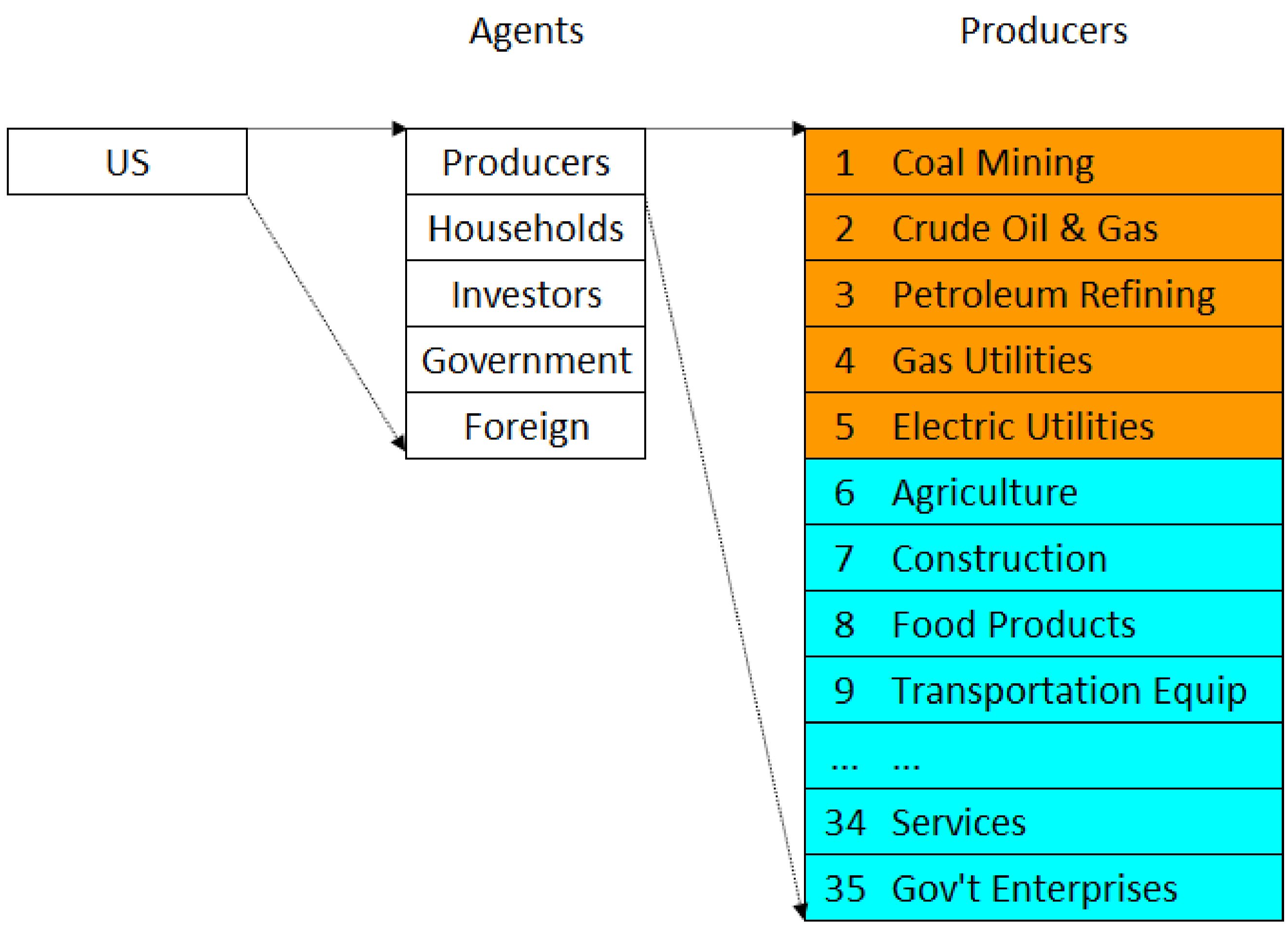
Answer using economic models

- Divide world into regions
- Divide regions into economic actors
  - Households
  - Manufacturing and service sector firms
  - Energy suppliers
  - Governments

Schematic view



Example: IGEM (used by the US EPA)



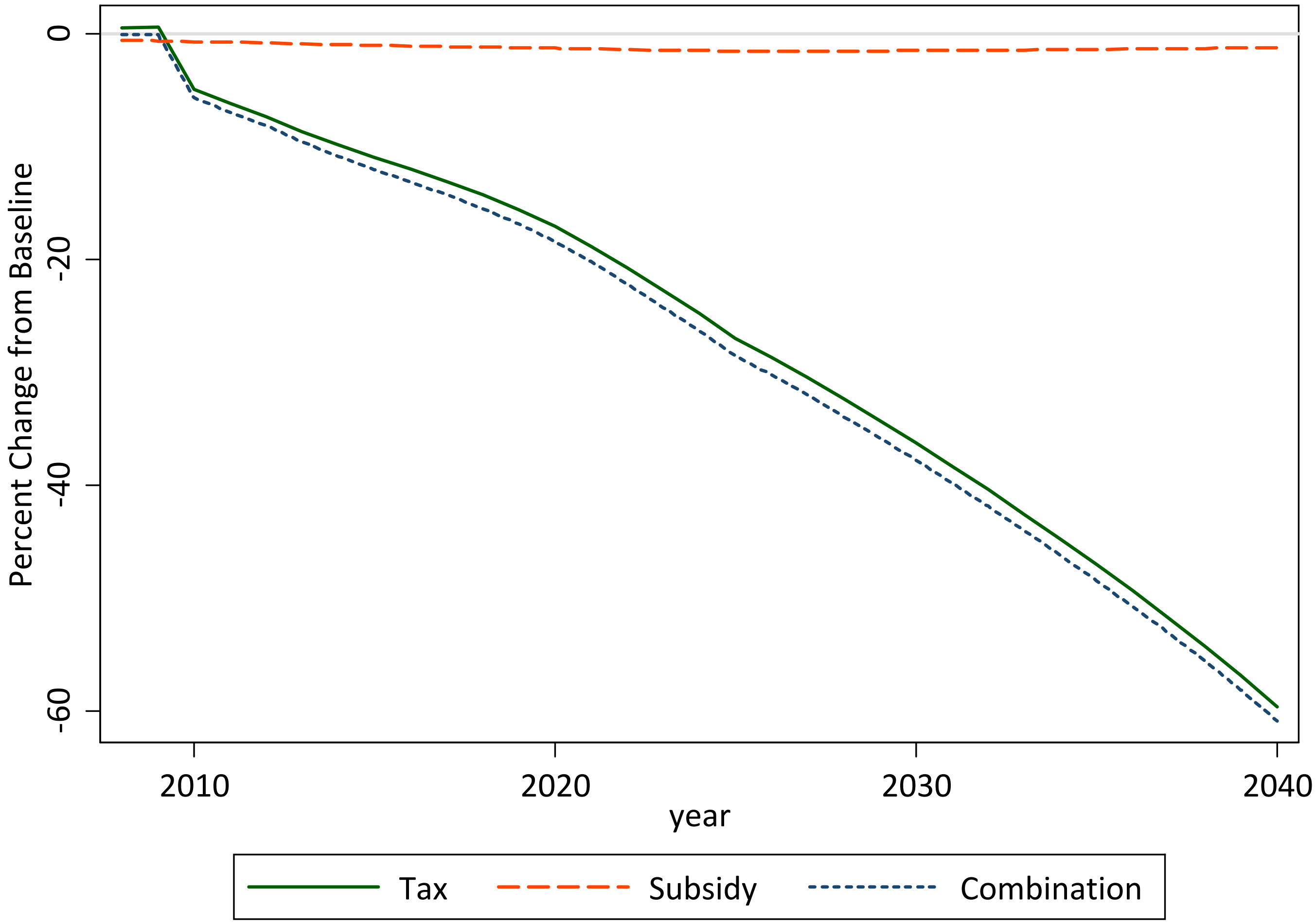
Component models of agents

- Households
  - Based on utility maximization
    - Demand equations for goods
    - Supply equations for labor and savings
- Firms
  - Based on profit maximization
    - Demand equations for fuels and inputs
    - Supply equations for goods and services
- Design of models
  - Straightforward extensions of those used in economics classes
- Estimation of parameters
  - Use techniques from statistics and quantitative classes

Example analysis

- Policy 1: carbon tax on fossil fuels
  - $30 per ton and rising at 5% per year
  - Raises considerable revenue
- Policy 2: investment tax credit for household energy efficiency
  - 10% credit for capital that is 20% more efficient than usual
  - Reduces revenue by an amount similar to policy 1
- Policy 3: policies 1 and 2 combined
  - Approximately neutral in revenue

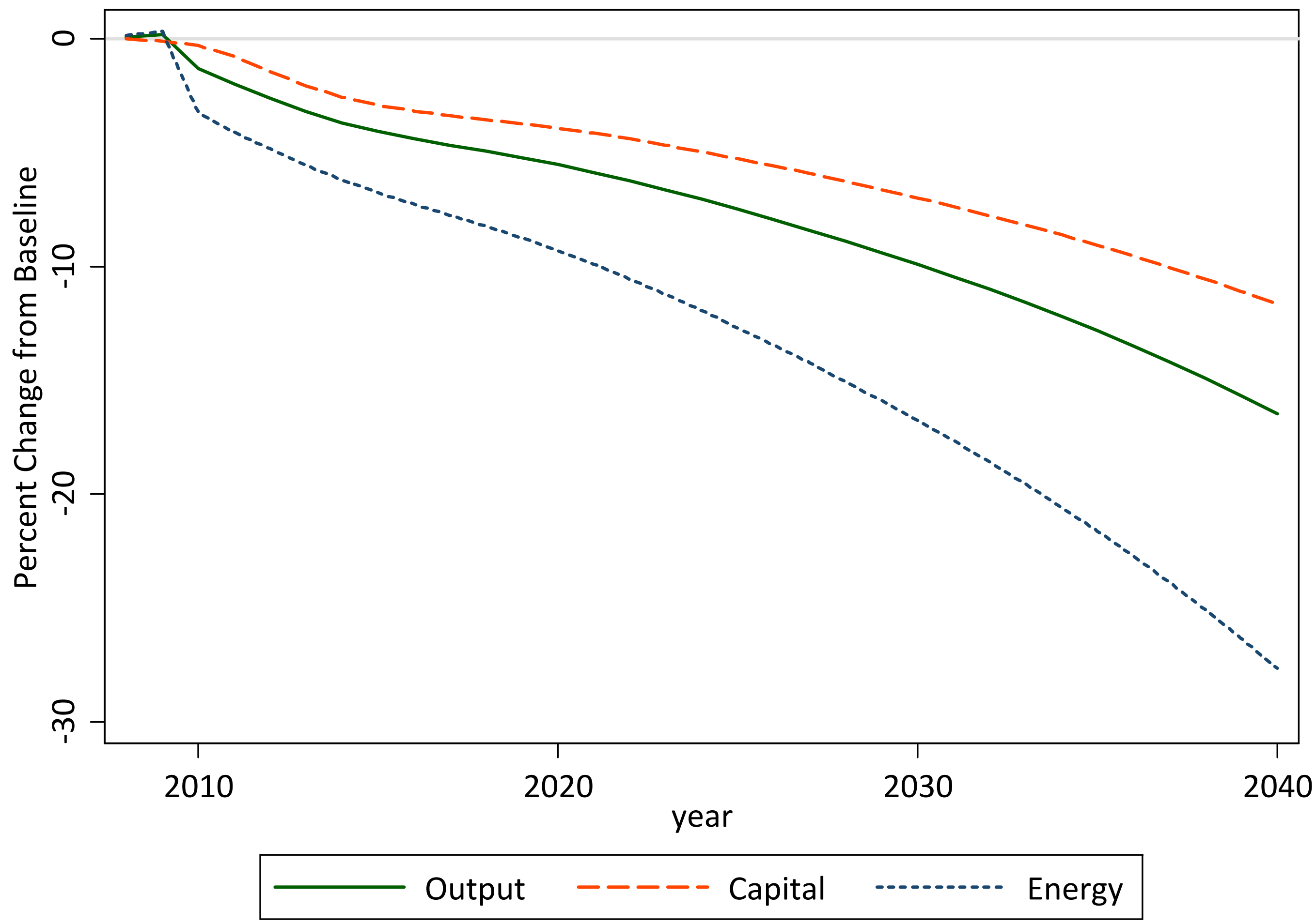
Effect on annual US CO2 emissions



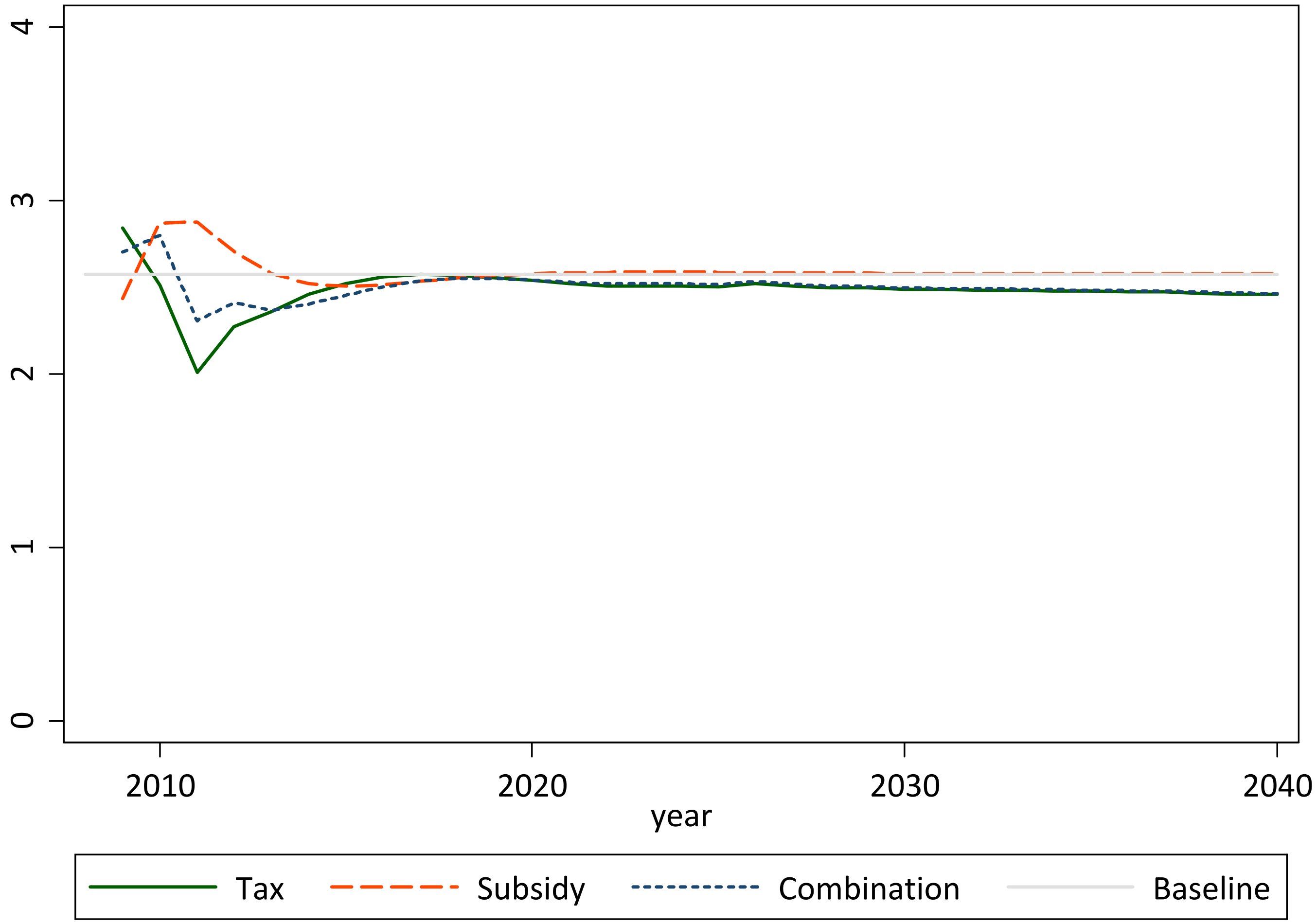
Effect on industry output in 2030

Num	Sector	Carbon Tax	Tax Credit	Combination
1	Electric Utilities	-9.9%	-0.9%	-10.8%
2	Gas Utilities	-4.5%	-1.0%	-5.5%
3	Oil Refining	-26.0%	-1.5%	-27.5%
4	Coal	-31.2%	-0.8%	-32.0%
5	Crude Oil and Gas	-31.8%	-1.5%	-33.4%
6	Other Mining	-3.0%	0.5%	-2.5%
7	Agriculture	-0.9%	0.0%	-1.0%
8	Forestry	-2.2%	0.4%	-1.8%
9	Durables	-3.3%	0.7%	-2.6%
10	Nondurables	-0.8%	-0.1%	-0.9%
11	Transportation	-1.1%	0.0%	-1.2%
12	Services	0.6%	-0.2%	0.5%

Effect of a carbon tax on inputs and outputs of utilities



Effect on the growth rate of real GDP



Summary

- Controlling climate change
  - Challenging: 86 quads to reduce
  - Possible: prices are very effective
  - Big effects on some industries and regions, not a big effect on GDP

- Tools from the core classes
  - Used directly and daily in major real-world policy analysis!