Modeling the Health Benefits of Carbon Emissions Reductions in China

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Overview

- A preliminary attempt to estimate potential health benefits from policies to reduce carbon emissions in China.
- We have integrated a model of the health effects of urban air pollution with a CGE model of the Chinese economy.
- In addition to the standard economic variables, outputs from the model include effects on human health and valuation of the damages.

Estimated Health Effects of Air Pollution in Urban China, 1995

- 178,000 premature deaths in urban areas.
- Hospital admissions 346,000 higher than if China's air pollution standards were met.
- 6.8 million additional emergency room visits.
- 4.5 million additional person-years lost because of pollution-related illness.
- Health damages valued at 5% of GDP.

Source: World Bank (1997).

Projected Health Effects of Air Pollution in Urban China, 2020

- 600,000 premature deaths in urban areas.
- 9 million person-years lost because of pollution-related illness.
- 20 million cases of respiratory illness per year.
- 5.5 million cases of chronic bronchitis.
- Health damages valued at 13% of GDP.

Source: World Bank (1997).

Main Features of Economic Model

- Dynamic recursive Solow growth model
- 30 sectors
- 5 energy sectors
- 1995 base year
- Includes both plan and market institutions
  - Two-tier plan/market price system
  - Investment allocated through plan and market channels

Components of Health Model

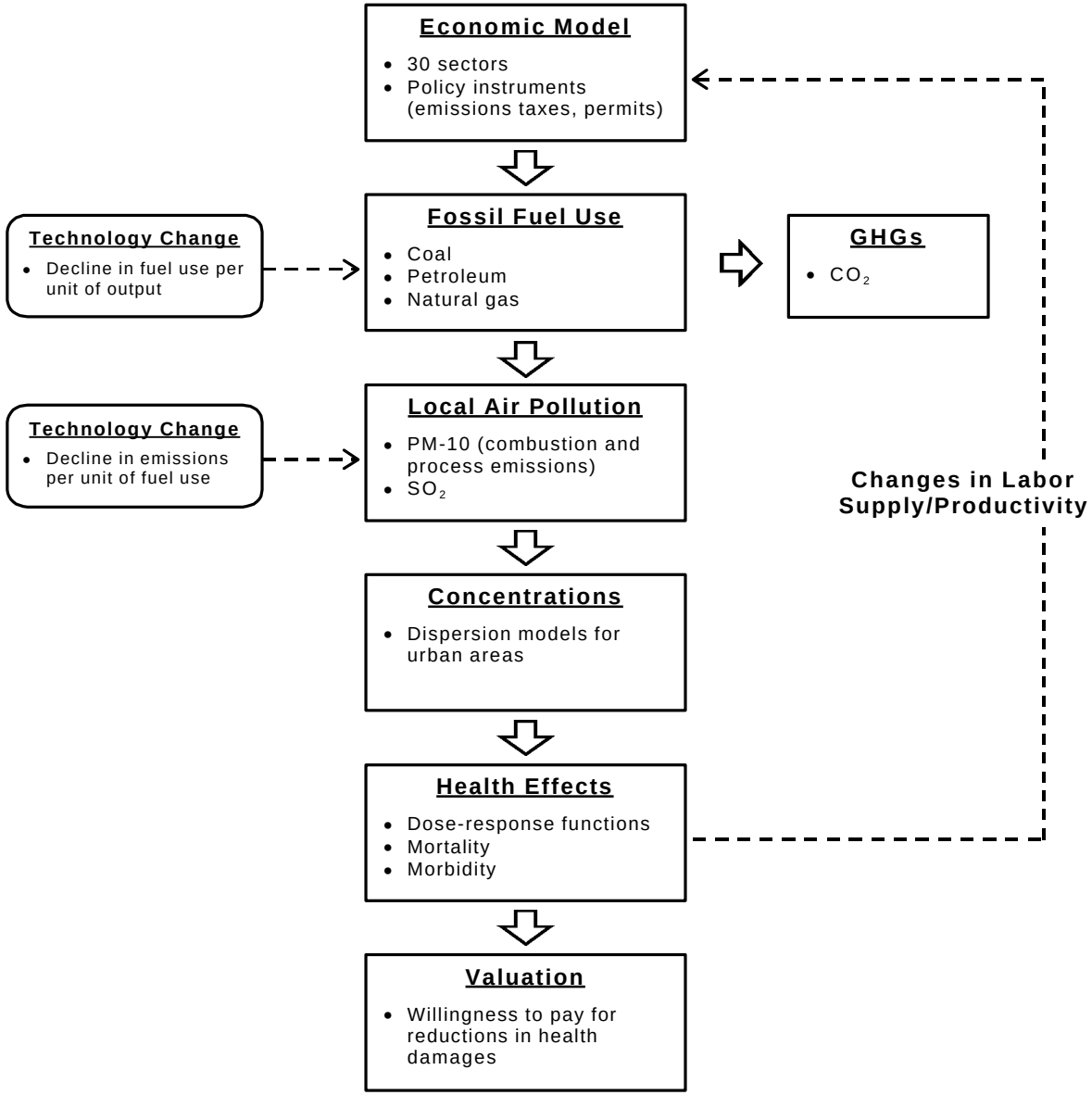
1) Generation of emissions

2) Emissions to concentrations in urban areas

3) Determination of health effects

4) Valuation of health effects

Flowchart: CGE Model for China with Health Effects



Generation of Emissions

- Combustion emissions (PM-10 and SO_2)
  - Related to sectoral fossil fuel use
- Process emissions (PM-10)
  - Related to sectoral output
- Parameters are assumed to change over time with improvements in technology and environmental regulation.

Emissions to Concentrations

- Dispersion models calculated for urban areas.
- Separate models for each of 11 large cities, smaller cities, and rest of urban population.
- Take into account data on meteorological conditions, land area, and emissions "stack height."
- Stack height is determined by sector:
  - Low: Agriculture, Construction, Services
  - Medium: Mining and Most Industry
  - High: Power Generation

Determination of Health Effects

- Dose-response functions relate changes in ambient concentrations of PM-10 and SO_2 to mortality and morbidity.
- Morbidity effects include: chronic bronchitis, respiratory hospital admissions, and asthma attacks.
- Parameters are taken from studies of China and other countries.

Valuation of Health Effects

- World Bank study uses "benefits transfer" to estimate "willingness to pay" for reductions in health effects in China.
- Valuation is based on WTP studies in the U.S. and other countries and adjusted by the ratio of income in China to income in the U.S.
- Valuation is expected to rise over time with increases in per capita income.

Design of Carbon Tax Simulation

1) Run base case (business as usual) simulation

2) Rerun model holding output of carbon to 10% of the base case in each period

   a) Carbon tax is made an endogenous variable

   b) Other taxes are reduced proportionately to keep simulations revenue neutral

Health Impacts of a 10% Reduction in Carbon Emissions, 2010

- 13% increase in (tax inclusive) price of coal
- 12% reduction in use of coal
- 6% reduction in particulate emissions
- 7% reduction in premature deaths
- 7% reduction in cases of chronic bronchitis

Economic Impacts of a 10% Reduction in Carbon Emissions, 2010

- GDP decreases slightly during initial years of simulation period. However, in every year after year 2, GDP is higher than in the base case.
- With the assumption of an inelastic supply of labor, carbon tax transfers income to enterprises. Increased investment increases the growth rate of GDP.
- Consumption falls initially, but (following GDP and investment) rise above the baseline after year 6.

Ongoing Work

- In collaboration with IQTE at CASS, constructing a time series of sectoral data to estimate production functions.
- Working with colleagues at Harvard and Tsinghua Universities to improve components of health effects model.
- Attempt to endogenize health effects on labor supply and productivity.