

# Modeling the Economic Impacts of Environmental Regulations using Economy-Wide Tools

The Case of Air Pollution Health Impacts

1. Why model the economic impacts of air pollution health effects?
2. Economic Impacts of the Clean Air Act's Health Effects
3. Improving Economic Modeling of Mortality Risk Reductions

The views expressed in this presentation are those of the author(s) and do not necessarily represent the views or policies of the EPA

# Non-Market Endpoints

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- ▶ Non-market benefits  $\neq$  No impact on markets
  - ▶ Non-market is only in reference to whether the affected endpoint is traded and therefore, explicitly valued in markets
- ▶ Utility function is non-separable in many environmental and health endpoints
  - ▶ A change in the endpoint can cause a change in behavior, including in markets
  - ▶ Forms the basis for revealed preference methods

# Health Endpoints Effect the Economy

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## Health Changes

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Premature mortality  
Cardiovascular disease  
Chronic lung disease  
Asthma exacerbation  
Acute respiratory symptoms  
Reproductive effects  
Development effects  
Neurologic effects  
Strokes

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## Potential Impacts

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Labor force size  
Savings & Consumption  
Hospital visits  
Non-hospital healthcare  
Restricted-activity days  
School absence days  
Worker productivity  
Occupational choice

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# Implications for Analysis of Environmental Policies

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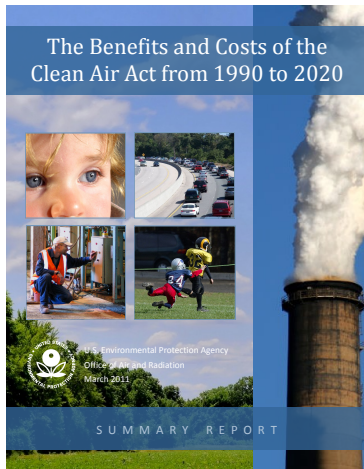
- ▶ Economic impacts of environmental policies of interest to policy makers and the public
  - ▶ Complete accounting of economic impacts may require consideration of health impacts
- ▶ General equilibrium (GE) analysis including the health impact may also be important for valuing welfare changes
  - ▶ Relative price changes can affect the demand for environmental quality (Carbone and Smith, 2013)
  - ▶ Capture potential interactions between costs and benefits

## Benefits-Side Tax Interaction Effects

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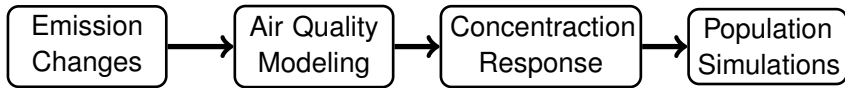
- ▶ Tax interaction effect is a known significant cost from compliance requirements
- ▶ Change in behavior from health impacts can also interact with pre-existing distortions
- ▶ Direction of net tax interaction effect is ambiguous if one relaxes separability assumption
  - ▶ Schwartz and Repetto (2000), Williams (2002)
- ▶ Can be numerically large for environmental policies
  - ▶ Carbone and Smith (2008)

# EPA's Clean Air Act Second Prospective Analysis



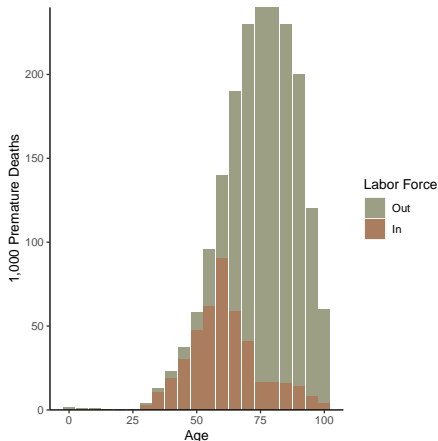
- ▶ EPA must conduct periodic evaluations of the impact on the public health, economy, and environment of the United States
- ▶ 2011 study considered the economy-wide impacts w/ a Computable General Equilibrium (CGE) analysis of:
  - ▶ Reduced mortality risks
  - ▶ Reduced morbidity risks
  - ▶ Decreased medical expenditures

# Modeling Mortality Impacts



- ▶ Estimate changes in population by year and cohort due to air pollution reductions
- ▶ Limited to labor force based on participation rates by cohort
- ▶ Expand time endowment for representative agent

Population Difference in 2020



Source: EPA's Second CAA Prospective Analysis



# Economic Impacts of the Clean Air Act

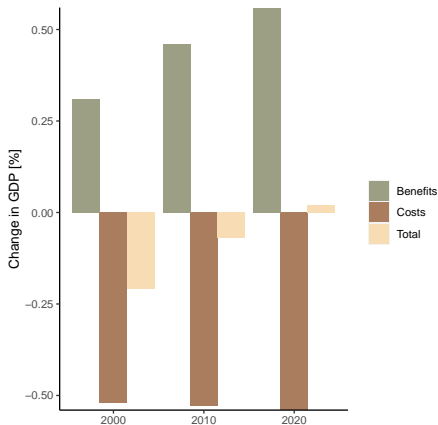
- ▶ Model health effects as:

- ▶ 0.3% - 0.6% increase in time endowment
- ▶ \$12 - \$20 billion reduction in medical expenditures

- ▶ Two scenarios:

- ▶ Costs only
- ▶ Costs and health impacts

## Clean Air Act GDP Impact



Source: EPA's Second CAA Prospective Analysis

# Time Endowment Approximation

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- ▶ Time endowment approximation to changes in mortality risks has been used in a variety of environmental contexts:
  - ▶ Li (2002), Yang et al (2005), Matus et al (2008), Mayeres and Van Regenmorter (2008), Selin et al (2009), Nam et al (2010), Matus et al (2012), Saari et al (2015), Giang and Selin (2016), Xie et al (2016), Wu et al (2017), and Xie et al (2018)
- ▶ How well does the time endowment approximation fit?
  - ▶ Do individuals react to an increase in time equivalently to a change in risks?
  - ▶ Behavioral changes for those outside the labor force?

# Mortality Risk Reduction vs. Time Endowment Increase

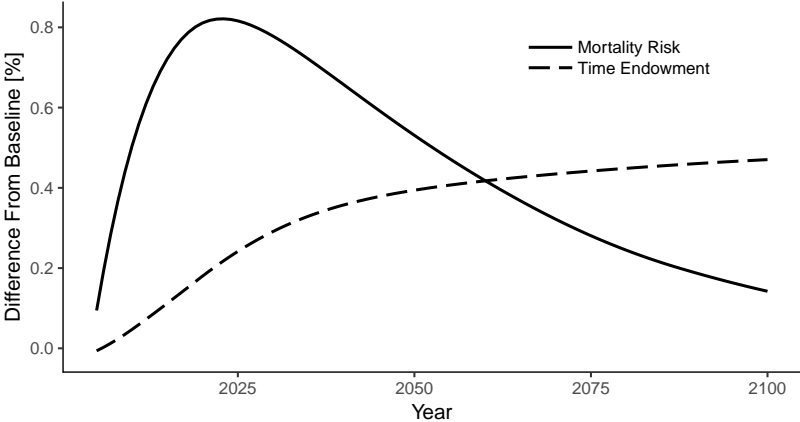
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- ▶ Marten and Newbold (2020) compare modeling explicit mortality risk reductions vs. time endowment approximation
- ▶ Overlapping generations GE model based on expected utility framework w/ explicit mortality risks
- ▶ Model the same set of Clean Air Act regulations as EPA's assessment using two scenarios:
  - ▶ Explicit shift in survival curve
  - ▶ Increase in cohort specific time endowment proportional to the cohort's expected population change by year

# Life Cycle Behavioral Response in Steady State



# Modeled Impact on GDP



Willingness to Pay for Clean Air Act  
Mortality Risk Reductions  
(Billion 2016\$)

Approach	Annualized WTP
Time Endowment	\$55
Mortality Risk	\$1,507
VSL*	\$1,216

\*Based on a life-cycle VSL schedule consistent w/  
the preferences in the GE model

# Summary

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- ▶ Impact of pollution on health affects behavior in markets
- ▶ Air pollution policies affect economic activity through beneficial impacts not just costs
  - ▶ Economic impact assessment will be incomplete without both of these effects
- ▶ General equilibrium effects may meaningfully affect willingness to pay for health impacts
- ▶ Approach to modeling health impacts will meaningfully affect the results