Economics 190/290 Lecture 3

Transportation Economics: The Costs of Driving, Part I

Air Pollution

Air Pollution and Auto Use

- **Autos and other "mobile source emitters" contribute substantially to urban air pollution**
  - Lead, sulfur dioxide
    - Lead causes developmental problems, SO2 impacts respiratory illness, heart, disease
  - Carbon Monoxide
    - Irritates respiratory tract, coronary damage
  - Nitrogen Oxides
    - Contributes to smog, exacerbates respiratory illness
  - Hydrocarbons
    - Contributes to smog, exacerbates respiratory illness
  - Particulate Matter
    - Elevates death rate, hospitalization rate for pulmonary diseases

History of Air Pollution Policies

- **Motor Vehicle Air Pollution Control Act of 1965**
- **Three Major Revisions of the Clean Air Act (1970, 1977, 1990)**
- **Three Major Goals of Legislation**
  - National technology mandates for cars, fuels
  - Mandates on state governments to curb auto use
  - Requirement that state transportation infrastructure investments be consistent with national air quality standards

History of Air Pollution Policies

- **National Ambient Air Quality Standards (NAAQS)**
  - Established by Clean Air Acts Amendments of 1970
    - Empowers EPA administrator to set allowable pollution levels for specific pollutants
    - Only allowed to take public health effects into account
    - EPA identifies "nonattainment areas", requires them to develop plans for pollution reduction by specified statuatory deadlines
    - Originally required NAAQS to be met by 1975, extended deadline to 1987 under 1977 amendments, extended them again in 1990

Technology Mandates for Autos, Fuel

- **Clean Air Act Amendments of 1970, 1977**
  - Required auto manufacturers to reduce emissions significantly (90% below previous standards) by 1975 model year
  - Effectively required auto manufacturers to develop mass-market, durable catalytic converters
  - Industry aggressively resisted mandates, sought (and received) extensions, particularly under 1977 Amendments
  - But emissions characteristics of new vehicles improved dramatically

Technology Mandates for New Vehicles, Fuel

- **Clean Air Act Amendments of 1970, 77**
  - Under 1970 amendments, EPA required oil refiners to market unleaded fuel by 1975 (to prevent damage to catalytic converters)
  - Reduce lead content in all gasoline
  - By 1993, market penetration of unleaded gasoline was 99%

Technology Mandates for New Vehicles, Fuel

- **Clean Air Act Amendments of 1990**
  - Banned lead in gasoline as of 1995, required "oxygenated" fuel in winter, "reformulated" fuel in summer
  - Mandated a new round of emissions reductions (Tier I controls) by 1994 model year
  - Established standards to control evaporative emissions
  - Allowed California to impose even stricter vehicle emissions standards, authorized other states to voluntarily adopt California standards

Technology Mandates for New Vehicles, Fuel

- **California's Standards**
  - Required greater emissions reductions than Federal Tier I regulation
  - Required that manufacturers market Zero Emission Vehicles (ZEWs) by 1998
  - Required that manufacturers achieve a 10% market share for ZEWs in California by 2003
  - ZEW mandate pushed back to 2003

Mandates on State Governments

- **Transportation controls**
  - EPA considered imposing draconian restrictions on downtown parking, retrofit of older vehicles with emissions controls, etc. to meet 1975 NAAQS attainment deadline
  - Proposed such plans for 19 non-attainment metropolitan areas in 1973, ordered Los Angeles to reduce gasoline consumption by 82%!
  - States refused to implement them

Mandates on State Governments

- **Transportation controls**
  - 1977 amendments did not place restrictions on personal travel
  - Instead, sought to involve environmental experts, environmental impact analysis into transportation planning
  - EPA sought to compel states to mandate inspections of emissions control. Many only did so when the federal government temporarily suspended highway funding

Mandates on State Governments

- **1990 Act and ISTEA**
  - Allowed for different attainment deadlines for different regions, depending on severity
  - More effectively induced states to consider environmental issues in transportation planning by changing the way federal transportation subsidies were disbursed

Have the Policies Worked?

- **Attempts to restrict auto use have largely failed**
- **Attempts to change the planning of transportation infrastructure have enjoyed limited success**
- **Auto manufacturers, oil refiners have responded to mandates by reducing emissions, marketing cleaner fuel**
- **There has been a substantial reduction in auto-related air pollutant emissions**

U.S. Air Pollution from Man-Made Sources

Source	Millions of Short Tons per Year				
	CO	NOx	Hcs	SOx	PM
Transportation	77	11	9	1	1
Fuel combustion	5	12	1	18	1
Industrial processes	7	1	11	2	1
Other	11	0	3	0	0
Total	98	24	23	22	4

Actual and Target Air Pollution Rates

	CO	NOx	Hcs
1970 (grams per vehicle mile)			
Actual, new models	58.0	4.4	4.8
Actual, all autos	52.3	4.3	9.4
1981 (grams per vehicle mile)			
Target, new models	3.4	1.0	0.4
Actual, new models	14.8	1.3	1.1
Actual, all models	24.3	3.1	3.6
Percentage reduction			
Target, new models	94	77	92
Actual, new models	74	70	77
Actual, all autos	54	28	62

	Pollutant				
	CO	NO_x	Hcs	SO_x	PM
% change	-56	-47	-66	+1	-30

Result	Pollutant	Number of cases avoided (thousands/year)	WTP per case avoided ($ thousands/case)
Mortality	PM	112–257	$5500
Chronic bronchitis	PM	674	296
Respiratory			
Hospitalized	PM,NO_x,HCs,CO	200	10
Acute	PM,NO_x,HCs	130,000	0
Restricted activity	PM,NO_x,HCs	22,600	0

Note: 0 means less than $500 per case avoided.

Failure at Cost-Effectiveness

- **Emissions per mile versus vehicle-miles traveled**
  - EPA regulations seeks to reduce the former, but total emissions are the product of the two
  - The theoretically optimal policy is a Pigouvian tax on emission

Failure at Cost-Effectiveness

- **New cars versus other vehicles**
  - EPA regulates new cars, not old ones. Induces consumers to use old vehicles.
  - Alternative policies
    - A registration tax that rises with age of car
    - "Cash for clunkers"
    - Stiff auto inspections that require repairs, maintenance for older, more polluting cars
    - Exemption from car-purchase taxes for consumers who "retire" an older, more polluting car

Failure at Cost-Effectiveness

- **Attainment vs. nonattainment areas**
- **Car-specific vs. fleet average controls**
  - A CAFE-like averaging across different models of each manufacturer's fleet
  - Marketable pollution standards
  - Averaging across pollutants

Failure at Cost-Effectiveness

- **Pollution standards in theory vs. practice**
  - New models are EPA-certified through testing of pre-production prototypes
  - Emissions control equipment is often not effective under actual driving conditions
  - Most car owners have no incentive to maintain their emissions control equipment

New Directions in Pollution Control

- **Less polluting fuels**
- **Battery-powered electric cars**
- **Hybrid cars**
- **But these are all being pushed by a "regulatory stick" rather than a "consumer carrot"**

Table 7-4. *Cost-Effectiveness of Technology Measures in Reducing Hydrocarbon Emissions*

(dollars)

Technology measures	*Cost per ton of HC reduced*
New auto emission standards	
1969 vs. uncontrolled	56[a]
1980–81 vs. 1977-79	3,500[a]
1994 vs. 1981	6,400[a]
Onboard refueling controls	1,100[a]
California gasoline vehicles	
TLEV	3,700–21,000[b]
LEV	2,200–27,000[b]
ULEV	4,200–41,000[b]
Alternative fuel vehicles	
Methanol	30,000–60,000[b]
Compressed natural gas	12,000–22,000[b]
Electric (ZEV)	29,000–108,000[b]
Gasoline reformulations	
11 to 9 Reid vapor pressure	500[a]
Federal standard	1,900-3,900[b]
California standard	4,100-5,100[b]
Inspection and maintenance	
EPA enhanced	4,500–$6,000[b]
Remote sensing	2,600–6,000[b]

Table 7-5. *Cost-Effectiveness of Transportation Control Measures in Reducing Hydrocarbon Emissions*
(dollars)

Control measure	*Cost per ton of HC reduced*	
	1990	*1997*
Bicycle, pedestrian paths	233,000	376,000
Employer trip reduction	227,000	365,000
Major rail transit improvements	220,000	353,000
Park-and-ride lots	118,000	188,000
HOV lanes	88,000	141,000
Congestion pricing	53,000	85,000
Incident management	. . .	83,000
Parking pricing: worktrips	38,000	61,000
Traffic signal timing	23,000	. . .
Areawide ridesharing	13,000	20,000
Buy-backs of older cars	3,000	. . .
Emissions/VMT tax	near 0	near 0

Other Policies

- **Emissions tax**

  Would be a subsidy for clean gas, LEVs, ZEVs
- **Stiff inspections for polluting cars**
- **Stricter standards in nonattainment areas**
- **Tighter controls on catalytic converter longevity**

Cost-Benefit Analysis of Pollution Control

- **Costs of pollution control: $650-$1,350 per car; $10 billion per year for the U.S.**
- **How to estimate the benefits?**

Cost-Benefit Analysis of Pollution Control

- **How to estimate the benefits?**
  - Estimate the actual degree of emissions reduction
  - Estimate the impact on ambient air quality of these emissions reductions
  - Estimate the benefits of improved air quality
  - Estimate people's willingness to pay for the health (and other) benefits of improved air quality

Are Pollution Controls Worth It?

- **EPA estimates $0.6-$1.4 *trillion***
  - But how many deaths really due to air pollution
  - Most who die of air pollution are over 65 – how much are their remaining years worth?
    - Conservative assumptions about death from PM and the worth of one's declining years reduce benefits to "only" $112 billion
    - There's been a 70% reduction in PM, but cars are only responsible for 2% of that – that could reduce benefits to $2-$25 billion

Global Warming and All That

- **Two kinds of pollution**
  - Local emissions that damage local ambient air quality: CO, smog, particulate matter
  - CO_2 emissions, which do not contribute to local air pollution, but may contribute to compositional changes in the stratosphere which could trap more solar heat, raising the Earth's average temperature

Global Warming and All That

- **Looming disaster?**
  - Higher global temperatures could lead to a melting of the polar ice caps. Over the next few centuries, the ocean level could rise by 25 feet, submerging coastal cities and farmland
  - Climactic patterns in U.S. would also be altered, with heat and drought in the south, possibly milder weather in the north

Global Warming and All That

- **Are cars killing us?**
  - Transportation accounts for about 1/3 of human-caused CO_2 releases in the U.S.
  - Transportation accounts for about ¼ of human-caused CO_2 releases in developing countries
  - But there's a great deal of scientific controversy about the contribution of human-caused emissions to global warming and even the degree of global warming itself

BOX 6.1 Annual Average Household CO_2 Emissions

Roughly half of the CO_2 emissions of the United States are from automobiles and residences. The major sources of these nonindustrial emissions are shown in the table below on a per capita basis.

Use	Unit	CO_2 per unit	Units consumed	CO_2 emissions
Automobile	Gallon	20	400	8000
Electricity	KWH	2	3600	7200
Heating				
Natural gas	Therm	12	200	2400
Oil and coal	—	—	—	1000

Note. KWH, kilowatt-hour. One therm = 100 cubic feet = 100,000 BTUs. BTU, British Thermal Unit. CO_2 is measured in pounds. Consumption and emissions are per annum. Sources: Bureau, 1995; EPA, 1995b; Hinrichs, 1996.

Global Warming and All That

- **3 Basic Facts**
  - Human-made carbon dioxide releases have been accelerating over the last century
  - Carbon dioxide is a “greenhouse” gas
  - The Earth has warmed over the past half century

Global Warming and All That

- **4 More Basic Facts**
  - Human-made carbon dioxide releases only account for about 3% of the global total
  - Many parts of the Earth have not warmed (such as the U.S.)
  - Geological evidence indicates that climate changes have occurred and reversed themselves many times over the Earth's history
  - Forecasts of the extent of global warming a fraught with uncertainty

Global Warming and All That

- **What is to be done?**
  - The U.S. generates about ¼ of global (man-made) carbon dioxide emissions – more than twice as much per capita as Western Europe
  - Nearly 1/3 of U.S. man-made carbon dioxide emissions come from cars
  - So, any attempt at carbon dioxide emissions reduction will involve our cars
  - But let's not be stupid about this

Global Warming and All That

- **"Robust" Policy Alternatives**
  - Further increase in fuel efficiency of the cars we now drive
  - Development of totally new types of vehicles: electric vehicles, fuel cells
  - Undertake policies to reduce driving
    - Taxes based on VMT
    - Taxes based on MPG
    - Taxes based on gasoline usage
    - The "carbon tax"

BOX 6.3 Comparison of Available Alternatives to Gasoline

All of the currently available alternatives to gasoline are more expensive than gasoline. The greater expense does not usually reside in explicit variable costs—most of the five alternatives in the next table would add little to a car's fuel and maintenance costs. The greater expense resides in the initial capital costs of the vehicle itself or of the fuel distribution network.[4]

All the alternative fuels are derived from either corn, coal, or natural gas, and all of these inputs are securely available in the United States or from secure, nearby foreign sources. All make some contribution to the air pollution problem. But none do much, if anything, for global warming—after all, they all involve burning that releases carbon dioxide.

Fuel alternative	National security	Air pollution	Global warming
Oxygenated gasoline	Raises oil imports	Much better	No effect
Ethanol (from corn)	Uses U.S. corn output	Slightly better	About the same
Methanol	Uses Canadian or U.S. natural gas	Slightly better	About the same
Natural gas	Uses Canadian or U.S. natural gas	Much better	Slightly better
Electric vehicle	Uses U.S. coal or natural gas	Much better in cities	Depends on how the electricity is generated

Sources: GAO, 1990; OTA, 1990; MacKenzie, 1994; Resolve, 1995.

Global Warming and All That

- **Global climate change treaties, and why they don't work**
  - The tragedy of the commons on the global scale
  - Rich nations produce most of the carbon, but little of their output is climate-dependent
  - Poor nations are more dependent on agriculture and forestry, but don't want to do anything to derail investment and economic growth

Global Warming and All That

- **Global climate change treaties, and why they don't work**
  - Rio de Janeiro, 1992
    - 170 nations agreed to reduce greenhouse gases to 1990 levels by 2000
    - Emissions levels continued to rise
  - Kyoto, 1997
    - U.S. agreed to cut emissions to 7% below 1990 levels by 2012
    - It ain't gonna happen

Global Warming and All That

- **Global climate change treaties, and why they don't work**
  - The Kyoto Targets and Economic Reality
    - U.S. greenhouse gas emissions grow at 1.3% per year
    - By 2012, we will be about 1/3 above 1990 levels
    - So, meeting the target requires a 30% reduction below projected levels
    - This would require that *every new car* sold by 2005 be a fuel-cell vehicle

Global Warming and All That

- **Cost-effective CO_2 reductions**
  - Autos emit 20 pds of CO_2 per gallon of gas (0.01 tons per gallon)
  - Price of gas is $1.20 per gallon
  - Americans consume 100 billion gallons per year
  - The short-run price elasticity of demand for gas is about 0.5

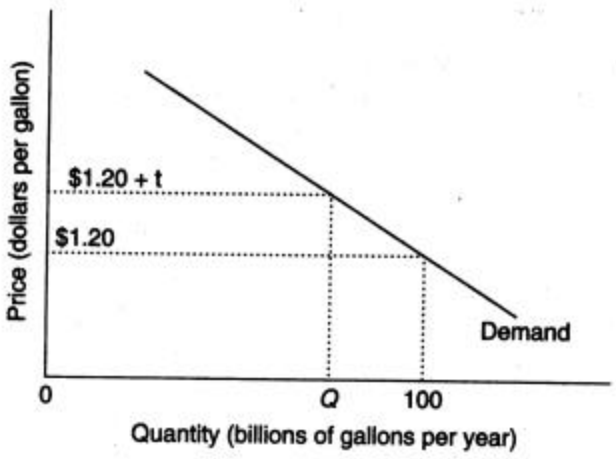

FIGURE 6.1 Effect of Gas Tax on Price and Quantity

Global Warming and All That

- **An additional tax rate of 10 cents per gallon**
  - Will cause a decline of 3.92 billion gallons consumed
  - Will cause a decline of 39.2 million tons of carbon dioxide
  - Will lead to a loss of consumer surplus of $9.8 billion, a net increase in tax revenue of $8.63 billion
  - Total net social cost: $1.18 billion, or about $30 per ton of carbon dioxide saved

Global Warming and All That

- **Figure 6.2 gives estimated social costs at different tax rates**
  - Clearly, gas taxes are a cost effective way to start fighting carbon dioxide emissions
  - Alternative policies will cost us much more than $40 per ton

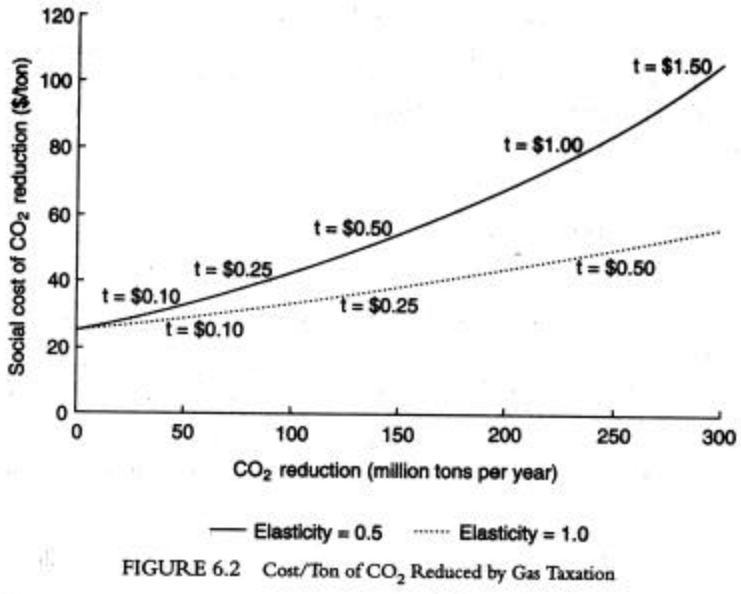

FIGURE 6.2 Cost/Ton of CO_2 Reduced by Gas Taxation