

#### Examples

- Obvious examples
  - Infectious diseases
  - Drunk driving
  - Second hand smoke
- Some not so obvious
  - Obesity or tobacco use increases costs of health insurance premiums for others
  - Your immunization reduces the chance that others will be infected

3

#### This section

- Examine in detail general topic of externalities
  - Define them
  - Why they are bad or good from an economic sense
  - How can we measure the size of welfare loss
- Show how taxes can be used to limit the social costs of an externality



• Extended example: Do smokers and drinkers pay their way?

- Alcohol and cigarette consumption generates externalities
- They are also taxed at the local, state and federal level
- Sum up the external costs of smoking/drinking
- Compare to the revenues raised by taxes
- Surprising results
- Excellent example of how economists look at problems

5



6

#### Consumer's Surplus

- Consumers continue to purchase so long as the value of the next unit is greater than price
- But all units priced the same
- Consumer's value the last unit at P<sub>1</sub>
- For all units consumed up to Q<sub>1</sub>, the value to the consumer exceeded price
- Area A represents consumer's surplus







## Producer's Surplus

- In competitive market, market supply curve is the horizontal summation of firm's marginal cost curve
- Height represents the amount firms must receive to sell the last
   unit
- Since this is the marginal cost curve, it also represents what it costs society to produce the last unit
- Difference between price received and the marginal cost of production is Producer's Surplus











### Negative Externalities

- · Pollution from a production process
- Noise from a nightclub near a residential neighborhood
- · The person next to you during an exam has a cold
- Second hand smoke

#### Positive Externalities

- You get a flu shot. This reduces the probability others will get the flu as well. You do not get the entire benefit although you paid all the costs
- Your beautiful garden raises the value of your neighbor's houseLojak:
  - Transmitted on car that can be used to locate a stolen vehicle
  - Reduced auto thefts in areas where it was introduced
  - Only a small fraction haVE Lojak. As a result, non-Lojak users benefit

17

Excess production and negative externalities

- Suppose production of the good generates externalities that are not reflected in costs of inputs (e.g., pollution)
- The true cost of producing the good is above the costs firms pay to produce
- Since firms are not paying all the costs of production, the 'wedge' between private costs and social costs encourages overproduction

#### Production externalities

- Perfectly competitive market. Supply Curve = marginal cost curve (MC)
- Not all costs of production are borne by the firm, e.g., pollution
- PMC = private marginal cost, the firm's costs, therefore, the industry supply
- SMC = social marginal cost
- SMC > PMC for all Q

19



<ul> <li>At market price P<sub>1</sub>, firms are willing to sell Q<sub>1</sub> units. However, from a social standpoint, if all costs were paid by the firm, they would only be willing to supply Q<sub>2</sub></li> <li>The firm overpreduces the good sizes they do not pay.</li> </ul>
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Q <sub>2</sub> • The firm every reduces the good since they do not per
• The firm overproduces the good since they do not new
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all the costs of production
• At $Q_1$ , the firm receives $P_1$ but it costs society MC <sub>3</sub> to
produce
r

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#### Social Costs of Overproduction

- Notice that as one moves from  $Q_2$  to  $Q_1$
- Society is spending an extra d+b+c on additional resources
- Consumers are however enjoying b + c in additional welfare
- · The difference is area d, the deadweight loss of overproduction
- If there ever is a 'wedge' between what it costs to produce a good and what people are paying for it, there will be a deadweight loss

25

What about negative consumption externalities?

- Start with a standard downward sloping demand for a good the private marginal benefit
- Consumption of the good however has health/financial costs to others (e.g., second hand smoke or drunk driving)
- Private Marginal Benefit > Social Marginal Benefit

26



At Q<sub>1</sub>, people value the last unit at P<sub>1</sub>
However, not all costs of the good are paid by the consumers
The SMB is SMB<sub>1</sub> which is lower than price
If people had to pay all the costs of the good (forget how they will do it for now), they would consume a lot less
Therefore, there is over-consumption of the good



• Di • Aş pri –	fference (area a) is the deadweight loss of over production ain notice the wedge between value of marginal good and ce of the product The marginal cost of producing the last unit is $P_1$ . The SMB is however only $SMB_2$	ı l the
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#### Internalize the Externality

- Per unit tax on output Pigouvian taxes
- "Excise tax"
- For every unit sold, charge consumers \$t in a tax
- The excise tax will shift down the demand curve by an amount equal to the tax
- Remember, the Y (price) axis is the price transacted between buyers and sellers, does not reflect true cost





- Without excise tax, at price P<sub>1</sub>, people willing to consume Q<sub>1</sub>
- With a tax of \$t/unit, price paid to sellers would have to fall to P-t in order to demand Q1
  - Pay P1-t to firm
  - Pay t to government
  - Pay P<sub>1</sub>-t +t = P<sub>1</sub> in total



#### Example

- Inverse demand: P=PMB=20 Q
- Inverse SMB: SMB = 20 2Q
- Inverse Supply: P=2+Q
- Market outcome
  - Supply = demand

$$-20 - Q = 2 + Q$$

- Q = 9
- P = 2+Q = 11





- People will demand Q=6 if P<sub>d</sub>=14
   PMB = 20 Q, so when P=14, Q=6
- Suppliers will supply 6 if  $P_s=8$
- P<sub>d</sub> is inverse demand
- P<sub>s</sub> is inverse supply
- With a tax, demand falls to P<sub>d</sub>-t and we equate P<sub>d</sub>-t=P<sub>s</sub>, so t=P<sub>d</sub>-P<sub>s</sub>
- Therefore,  $t=P_d-P_s=14-8=6$



# Can show a per unit tax on suppliers can also solve externality problem

- Per unit tax will shift up supply curve by an amount t
- Verticle axis is amount transacted between buyers/sellers
- Without tax, at price P1 producers willing to supply Q1.
- When tax is imposed, suppliers receive a price, then pay t back to the government
- In order fir supply to stay at  $\mathrm{Q}_1$  with a tax, their price must rise to  $\mathrm{P}_1 +$  t











SMC

PMC







Р 20

14







- Alcohol and cigarettes are taxed at the federal, state and local level
- Some states sell liquor rather than tax it (VA, PA, etc.)
- Most of these taxes are excise taxes -- the tax is per unit - Rates differ by type of alcohol, alcohol content
  - All cigarettes taxed the same
- Revenues from cigarette taxes in 2016
  - \$17 billion at state and local level
  - \$14 billion at Federal level
  - \$8.0 billion in Master Settlement Payments



#### Current Cigarette Excise Tax Rates

• States

- Low: MO(\$0.17), VA(\$0.30), GA(\$0.37)
- High: NY(\$4.35), CT (\$4.35), RI(\$4.25)
- Average of \$1.75 across states
- Federal:
  - \$1.0066/pack
- State+local
  - Chicago (\$6.16), NYC (\$5.85), Juneau (\$5.00)

53

#### Federal Taxes on Alcohol

- Beer
  - \$18/31 gallon barrel or \$0.05/12 ounce can
- Wine
  - \$0.21/750ml bottle for 14% alcohol or less
  - 0.31/750ml bottle for 14 21% alcohol
- Liquor, \$13.50 per 100 proof gallon (50% alcohol), or, \$2.14/750 ml bottle of 80 proof liquor

NYC

- Cigarettes
  - Local+state+federal=1.50+4.35+1.01=\$6.86 per pack
  - One carton of cigarettes costs \$68.60 in taxes
- Case of wine
  - state+federal = 0.059+0.21=\$0.269 per bottle
  - \$3.23/case
  - Would need to buy 21 cases of wine to pay the same tax as one carton of cigarettes

56

54

## State taxes on Alcohol

- Beer
  - High: \$1.29/gallon Tennessee
  - Low: \$0.06/gallon (WI and MO)
- Wine
  - High: \$3.17/gallon KY
  - Low: no tax in PA, VT, WY, UT, MS
- Spirits
  - High: \$35.22/gallon Washington
  - Low: \$0.00/gallon (WY, NH)

#### Do taxes reduce consumption?

#### Law of demand

- Fundamental result of micro economic theory
- Consumption should fall as prices rise
- Generated from a theoretical model of consumer choice
- Thought by economists to be fairly universal in application
- Medical/psychological view certain goods not subject to these laws

57

- Starting in 1970s, several authors began to examine link between cigarette prices and consumption
- Simple research design
  - Prices typically changed due to state/federal tax hikes
  - States with changes are 'treatment'
  - States without changes are control

58

- Near universal agreement in results
  - 10% increase in price reduces demand by 4%
  - Change in smoking evenly split between
    - Reductions in number of smokers
    - Reductions in cigs/day among remaining smokers
- · Results have been replicated
  - in other countries/time periods, variety of statistical models, subgroups
  - For other addictive goods: alcohol, cocaine, marijuana, heroin, gambling

- Taxes now an integral part of antismoking campaigns
- Key component of 'Master Settlement'
- Surgeon General's report
  - "raising tobacco excise taxes is widely regarded as one of the most effective tobacco prevention and control strategies."
- · Tax hikes are now designed to reduce smoking











$S_{ijt} = 1 if person i, state j, year t smokes$ $= 0 otherwise$ $C_{ijt} = cigs / day for S_{ijt} = 1$	Generating an Elasticity $Q = Pr(S = 1) \times C$ where $C = Cigs   S = 1$
For everyone: $S_{ijt} = \alpha_1 + tax_{jt}\theta_1 + x_{ijt}\beta_1 + u_{1j} + \lambda_{1t} + \varepsilon_{1it}$	$\frac{\partial Q}{\partial tax} = \frac{\partial \Pr(S=1)}{\partial tax}C + \frac{\partial C}{\partial tax}\Pr(S=1)$ $= \theta_1 C + \theta_2 \Pr(S=1)$
If $S_{ijt} = 1$ $C_{ijt} = \alpha_2 + tax_{jt}\theta_2 + x_{ijt}\beta_2 + u_{2j} + \lambda_{2t} + \varepsilon_{2it}$	$\xi_{d} = \frac{\partial \mathbf{Q}}{\partial \mathbf{P}} * \left(\frac{P}{\mathbf{Q}}\right)$ $Q = f(P(tax))$
$x_{ijt} = demographic \ controls$ $u, \lambda = state \ and \ year \ effects$ <sup>67</sup>	$\frac{\partial Q}{\partial tax} = \frac{\partial Q}{\partial P} \left( \frac{\partial P}{\partial tax} \right)$



OLS Estimates of UPC-Level Real Retail Price Equation, IRI Data 2001-2006			
Covariate	(1)	(2)	
Real tax (\$/pack)	0.993	0.987	
	(0.089)	(0.079)	
	[0.938]	[0.872]	
Month/year effects	Yes	Yes	
State Effects	Yes	Yes	
UPC effects	No	Yes	
Observations	1,126,478	1,126,478	
Distinct UPCs	2,843	2,843	
$\mathbb{R}^2$	0.687	0.939	

Generating an Elasticity	
$\xi_d = \frac{\partial Q}{\partial tax} * \left(\frac{P}{Q}\right) / \left(\frac{\partial P}{\partial tax}\right)$	
$\xi_d = \left[\theta_1 C + \theta_2 \operatorname{Pr}(\mathbf{S}=1)\right] * \left(\frac{P}{Q}\right) / \left(\frac{\partial P}{\partial tax}\right)$	
$Q = \Pr(S = 1)C$	
$\xi_{d} = \left( \left[ \theta_{1} P / \Pr(S=1) \right] + \left[ \theta_{2} P / C \right] \right) / \left( \frac{\partial P}{\partial tax} \right)$	
	71

Two-Part C	ligarette Deman	arette Demand Model Estimates, Adults Mean values			ts aged 18+, BRFSS Data, 1985–1995 Parameter estimates (standard errors) [price elasticity] on real tax	
Sample	Obs.	Smoker	Cigs./day (smokers only)	Smoker linear probability	Cigs./day (smokers only), OLS	Total elasticity
Full	812,185	0.240	18.7	-0.00019 (0.00006) [-0.144]	-0.0152 (0.0034) [-0.149]	[-0.293] (0.057)
	$\xi_d = ([$	$(\theta_1 P / \Pr($	$S=1)]+[\theta]$	$\left(\frac{\partial c}{\partial t}\right) / \left(\frac{\partial c}{\partial t}\right)$	$\left(\frac{\partial P}{tax}\right)$	
Pr(S=1)=	0.24 =(	(-0.0001	9*183/0.	24)+(-0.01	52*183/1	8.7))/1.00
C=18.7 P=183	= -	0.144-0	0.149 = -0.	293		72

#### External costs of poor health

· Manning et al. paper

Accounting exericise

- What are the external costs of alcohol, tobacco, sedentary lifestyle
   Will focus on the 1<sup>st</sup> two in class
- Consider three sets of costs
  - Direct costs
  - · Lives lost, fires, criminal justice
  - Collectively financed programs
    - Sick/medical leave, all types of insurance, retirement, federal transfer programs
  - Taxes on earnings

73

## Direct costs

- Lives lost due to poor health
  - Drunk driving deaths
  - Fires from smoking
  - Does not include
    - Death of the person
    - Any other family member (why is this? Is this a good assumption?)
    - · Second hand smoke
- · Criminal justice costs

#### 74

#### Collectively financed programs

- Health/life insurance
  - Costs of a smoker are paid collectively by those enrolled in an insurance program
  - Externalities can be reduced if premiums are correlated with smoking
- Gov't transfer programs tricky
  - Smoking/drinking increases current costs in Medicare/Medicaid
  - May decrease costs in the future

75

#### Taxes on Earnings

- · Smokers and heavy drinkers
  - Are less productive during working years (do not know whether this is causal)
  - If die prematurely, pay less in state/local income taxes



- The smoker/drinkers diminished health or the health of their family members
- The lost earnings of these activities
- Why?

Expenditures are correlated with longevity

Social security, Medicare/Medicaid costs increase for older people

Because smoking kills people early

Prevents people from getting to the age when medical costs are very high

Special case of Federal Programs

- Reduces payment of Social Security benefits

77

79

From the perspective of the other taxpayers, these are positive externalities
Smokers pay \$ to Federal and states

• They do not take as much out (SS, Medicare/caid) because they die early

	(5% discount rate)			
	Cigarettes	Heavy drinking		
	(per pack)	(per ounce)		
Collectively financed	\$0.05	\$0.23		
Direct costs	\$0.02	\$0.93		
Taxes on earnings	\$0.09	\$0.06		
Total	\$0.15	\$1.19		

	Cigarette
	(per pack
Medical costs	\$0.26
Sick leave/life	\$0.06
Nursing homes	-\$0.03
Pensions	-\$0.24

	Cigarettes	Heavy drinking	
	(per pack)	(per ounce)	
External costs	\$0.16	\$1.19	
Total taxes	\$0.37	\$0.20	



- Between 1986 and now, prices have doubled
  - CPI, Jan 1986 = 109.6
  - CPI, Dec 2012 = 225.9
- Holding all else fixed, external costs have moved to \$0.30/pack
- If assume all deaths due to fires and passive smoke are external costs

- Smoking cost rises to \$0.29/pack In 1986 dollars
- Roughly \$0.60/pack in todays dollars
- Average state tax=\$1.48, Federal tax=\$1.00













- People trade off \$ for job characteristics
  - Jobs with nice characteristics paid less
  - Jobs with unattractive characteristics paid more
  - Hold ALL ELSE CONSTANT
- One characteristic is job risk
- Workers in higher risk jobs get paid more
- Can use the willingness to accept risk to calculate a 'statistical value of life'

91

- Among blue collar workers, there is a 1 in 10,000 chance of dying on the job during the year.
- People in jobs with twice the average risk are estimated to make \$500 more than identical people in average risk jobs.
- For every additional 10,000 workers in high-risk jobs, they will receive and extra \$500 x 10,000 = \$5 million in income

90

- But among these additional workers, on average, 1 will die.
- VSL=value of a statistical life
- VSL = additional income people are willing to take for additional risk/expected additional deaths
- Example: Suppose that a group of workers requires an additional \$350 to accept an additional risk of death of 0.000152
- Just divide \$350/0.000152 = \$2.3 million
- Suppose there are an addition 50000 workers
  - Take home an additional 50000\*350 = \$17.5 million
  - But an additional 50000\*0.000152 = 7.6 will die
  - 17.5/7.6=\$2.3 million



- 17,000 MV deaths due to drunk drivers in 2003
  - down from 26K in 1981
  - 40% of all MV deaths in 2003
  - The drunk drivers themselves are 2/3rds of the alcoholrelated MV fatalities, so you only count the 1/3 left over
- External costs of alcohol are now much lower -- probably too high by 34%

Viscus Costs of	i (1995) Smoking	
• External insurance costs p	er pack (1993\$)	
<ul> <li>Medical care</li> </ul>	\$0.388	
Sick leave	\$0.016	
<ul> <li>Group life insuance</li> </ul>	\$0.072	
<ul> <li>Nursing home care</li> </ul>	-\$0.062	
<ul> <li>Retirement pensions</li> </ul>	-\$0.286	
• Fires	\$0.092	
• Total	\$0.238	
• Taxes paid	\$0.53/pack	94



#### Second hand smoke risks -- BMJ

- Study of 36,000 never smokers in CA, 1960-1998
- No significant associations were found for current or former exposure to environmental tobacco smoke before or after adjusting for seven confounders and before or after excluding participants with pre-existing disease.
- The results do not support a causal relation between environmental tobacco smoke and tobacco related mortality, although they do not rule out a small effect. The association between exposure to environmental tobacco smoke and coronary heart disease and lung cancer may be considerably weaker than generally believed.



97

Viscusi

Survey, "of 100 smokers, how many will get lung cancer because they smoke?"

Survey responses

Survey responses

Non smokers

The true risk level is

People over state the risk of smoking

99

fe Tabl Value
100
93
87
39
100
84
90
37

#### Do smokers underestimate the addictiveness of smoking?

- 82% of smokers say the would like to quit
  - About 50% of ever smokers eventually quit
  - What does this measure?
- Survey of HS smokers
  - 56% say they will NOT be smoking in 5 years
  - Only 31% actually quit
  - Among pack a day smokers
    - 72% who say they will quit in 5 yrs are still smoking
    - 74% who say they will not quit in 5yrs are still smoking