


Obvious examples

- Drunk driving

Secor so

- Obesity or tobacco use increases costs of health insurance premiums for others
Your immunization reduces the chance that others will be infected


## Introduction

- Much of morbidity and mortality is caused by behavior
- $50 \%$ of all deaths (tobacco, alcohol, driving, etc)
- Sometimes these behaviors only impact the individual making the decision
- Other times, the behavior can impact others
- Financially
- Health wise


## 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


## This section

- 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


## 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 $P_{1}$
- For all units consumed up to $\mathrm{Q}_{1}$, the value to the consumer exceeded price
- Area A represents consumer's surplus


## Example

- Inverse demand curve
- $\mathrm{P}=100-4 \mathrm{Q}$
- When $\mathrm{Q}=0, \mathrm{P}=100$
- When $\mathrm{P}=0, \mathrm{Q}=25$
- Suppose $\mathrm{P}=40, \mathrm{Q}=15$
- $\mathrm{CS}=(1 / 2)$ Height*base
- REV=P*Q



## 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 house
- Lojak:
- 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

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
- $\mathrm{PMC}=$ private marginal cost, the firm's costs, therefore, the industry supply
- $\mathrm{SMC}=$ social marginal cost
- SMC > PMC for all Q



- Market output $\left(\mathrm{P}_{1}, \mathrm{Q}_{1}\right)$
- At $\mathrm{Q}_{1}, \mathrm{SMC}_{1}>\mathrm{P}_{1}$
- Costing society more to produce than is transacted in the market
- Social optimum $\left(\mathrm{P}_{2}, \mathrm{Q}_{2}\right)$


## Social Costs of Overproduction

- Notice that as one moves from $Q_{2}$ to $Q_{1}$
- Society is spending an extra $\mathrm{d}+\mathrm{b}+\mathrm{c}$ on additional resources
- Consumers are however enjoying $\mathrm{b}+\mathrm{c}$ 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

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

- At $\mathrm{Q}_{1}$, people value the last unit at $\mathrm{P}_{1}$
- However, not all costs of the good are paid by the consumers
- The SMB is $\mathrm{SMB}_{1}$ 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



## 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

- Vertical axis, amount transacted between buyers and sellers
- Without excise tax, at price $P_{1}$, people willing to consume $\mathrm{Q}_{1}$
- With a tax of \$t/unit, price paid to sellers would have to fall to P-t in order to demand $\mathrm{Q}_{1}$
- Pay $P_{1}-t$ to firm
- Pay $t$ to government
- Pay $P_{1}-t+t=P_{1}$ in total

- Social optimum
- Supply $=$ Social Marginal Benefit
$-2+Q=20-2 Q$
$-\mathrm{Q}=6$
$-P=2+Q=8$
- What tax should be charged to obtain the social optimum?
- Want output to be $\mathrm{Q}=6$.
- Must choose a tax rate that reduces demand to 6
- People will demand $\mathrm{Q}=6$ if $\mathrm{P}_{\mathrm{d}}=14$
- $\mathrm{PMB}=20-\mathrm{Q}$, so when $\mathrm{P}=14, \mathrm{Q}=6$
- Suppliers will supply 6 if $\mathrm{P}_{\mathrm{s}}=8$
- $P_{d}$ is inverse demand
- $\mathrm{P}_{\mathrm{s}}$ is inverse supply
- With a tax, demand falls to $P_{d}-t$ and we equate $P_{d}-t=P_{s}$, so $\mathrm{t}=\mathrm{P}_{\mathrm{d}}-\mathrm{P}_{\mathrm{s}}$
- Therefore, $\mathrm{t}=\mathrm{P}_{\mathrm{d}}-\mathrm{P}_{\mathrm{s}}=14-8=6$


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 $P_{1}$ producers willing to supply $Q_{1}$.
- When tax is imposed, suppliers receive a price, then pay t back to the government
- In order fir supply to stay at $Q_{1}$ with a tax, their price must rise to $\mathrm{P}_{1}+\mathrm{t}$

- At $P_{1}$, firms were willing to supply $Q_{1}$
- With an excise tax, in order for firms to supply $Q_{1}$, the price must increase to $\mathrm{P}_{1}+\mathrm{t}$
- Firm receives $P_{1}+t$
- Pay the government t in taxes
- Net $P_{1}$
- Therefore, an excise tax will shift the supply curve up by the amount of the tax


- Social Optimum: $\mathrm{P}_{\mathrm{d}}=\mathrm{P}_{\text {sc }}$
- $20-2 \mathrm{Q}=2+2 \mathrm{Q}$
- $\mathrm{Q}=4.5, \mathrm{P}=11$
- At the Market output, $\mathrm{Q}=6$, so $\mathrm{SMC}=14$
- DWL = area d
- $\mathrm{D}=(1 / 2)$ Height*base

$$
=(1 / 2)(6-4.5)(14-8)=4.5
$$



## Example

- Demand:
- PMC:
- SMC:

$$
\begin{aligned}
& \mathrm{P}_{\mathrm{d}}=30-.3 \mathrm{Q} \\
& \mathrm{P}_{\mathrm{s}}=2+0.1 \mathrm{Q} \\
& \mathrm{SMC}=2+.2 \mathrm{Q}
\end{aligned}
$$

- Social optimum
- $\mathrm{P}_{\mathrm{d}}=\mathrm{SMC}$
- $30-.3 \mathrm{Q}=2+.2 \mathrm{Q}$
- $28=.5 \mathrm{Q}$
- $\mathrm{Q}=56, \mathrm{P}=13.2$
- Market equilibrium
- $\mathrm{P}_{\mathrm{d}}=\mathrm{P}_{\mathrm{s}}$
- $30-.3 \mathrm{Q}=2+.1 \mathrm{Q}$
- $28=0.4 \mathrm{Q}$
- $\mathrm{Q}=70, \mathrm{P}=9$
- What is the optimal tax?
- Want $Q=56$, the social optimal
- People will demand 56 when their price is 13.2
- What price will encourage firms to supply 56 ?
- Firms will receive $\mathrm{P}+\mathrm{t}$, but they have to give t back to the government.
- $\mathrm{P}=2+.1 \mathrm{Q}=2+.1(56)=7.6$
- When firms receive 7.6 , they will supply 56 .
- Therefore $13.2-7.6=5.6(\operatorname{tax})$




## 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)


## 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: $\quad \$ 0.00 /$ gallon (WY, NH)

|  |  |
| :--- | :--- |
|  |  |
|  |  |
| - Beer |  |
| - High: | $\$ 1.29 /$ gallon Taxes on Alcohol |
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| - Spirits |  |
| - High: | $\$ 35.22 /$ gallon Washington |
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Federal Taxes on Alcohol

- Beer
- $\$ 18 / 31$ gallon barrel or $\$ 0.05 / 12$ ounce can
- Wine
- $\$ 0.21 / 750 \mathrm{ml}$ bottle for $14 \%$ alcohol or less
- $\$ 0.31 / 750 \mathrm{ml}$ 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


## 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
- Starting in 1970 s, 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
- 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
- By the end of 1996
- 9 states with cigarette excise taxes of $\$ 0.50$
- only 3 states with taxes in excess of $\$ 0.75 /$ pack.
- By the end of 2002
- 24 states had taxes of $\$ 0.50$ or more
- 13 states having a tax of a dollar per pack or more.
- Today
- 18 states with taxes $>=\$ 2 /$ pack
- 32 states with taxes $>=\$ 1 /$ pack



$S_{i j t}=1$ if person $i$, state $j$, year $t$ smokes $=0$ otherwise
$C_{i j t}=$ cigs $/$ day for $S_{i j t}=1$

For everyone :
$\mathrm{S}_{i j t}=\alpha_{1}+\operatorname{tax}_{j t} \theta_{1}+x_{i j t} \beta_{1}+u_{1 j}+\lambda_{1 t}+\varepsilon_{1 i t}$

If $S_{i j t}=1$
$\mathrm{C}_{i j t}=\alpha_{2}+\operatorname{tax}_{j t} \theta_{2}+x_{i j t} \beta_{2}+u_{2 j}+\lambda_{2 t}+\varepsilon_{2 i t}$
$x_{i j t}=$ demographic controls
$u, \lambda=$ state and year effects
Generating an Elasticity
$Q=\operatorname{Pr}(\mathrm{S}=1) \times C$
where $C=$ Cigs $\mid S=1$
$\frac{\partial Q}{\partial \operatorname{tax}}=\frac{\partial \operatorname{Pr}(S=1)}{\partial \operatorname{tax}} C+\frac{\partial C}{\partial \operatorname{tax}} \operatorname{Pr}(\mathrm{~S}=1)$
$=\theta_{1} C+\theta_{2} \operatorname{Pr}(\mathrm{~S}=1)$
$\xi_{d}=\frac{\partial \mathrm{Q}}{\partial \mathrm{P}} *\left(\frac{P}{\mathrm{Q}}\right)$
$Q=f(P(t a x))$
$\frac{\partial \mathrm{Q}}{\partial \operatorname{tax}}=\frac{\partial \mathrm{Q}}{\partial \mathrm{P}}\left(\frac{\partial P}{\partial \operatorname{tax}}\right)$


|  | Generating an Elasticity |
| ---: | :--- |
| $\xi_{d}=\frac{\partial Q}{\partial \operatorname{tax}} *\left(\frac{P}{\mathrm{Q}}\right) /\left(\frac{\partial P}{\partial \operatorname{tax}}\right)$ |  |
| $\xi_{d}=\left[\theta_{1} C+\theta_{2} \operatorname{Pr}(\mathrm{~S}=1)\right] *\left(\frac{P}{\mathrm{Q}}\right) /\left(\frac{\partial P}{\partial \operatorname{tax}}\right)$ |  |
| $Q=\operatorname{Pr}(S=1) C$ |  |
| $\xi_{d}=\left(\left[\theta_{1} P / \operatorname{Pr}(S=1)\right]+\left[\theta_{2} \mathrm{P} / \mathrm{C}\right]\right) /\left(\frac{\partial P}{\partial \operatorname{tax}}\right)$ |  |



## External costs of poor health

- Manning et al. paper
- Accounting exericise
- What are the external costs of alcohol, tobacco, sedentary lifestyle
- Lives lost due to poor health
- Will focus on the $1^{\text {st }}$ 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


## Direct costs

- 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


## 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


## 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


## What is NOT an external cost

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

Special case of Federal Programs

- 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
- Reduces payment of Social Security benefits

|  | External costs of smoking/drinking <br> $(5 \%$ discount rate) |  |
| :--- | :--- | :--- |
|  | Cigarettes <br> (per pack) | Heavy drinking <br> (per ounce) |
| Collectively financed | $\$ 0.05$ | $\$ 0.23$ |
| Direct costs | $\$ 0.02$ | $\$ 0.93$ |
| Taxes on earnings | $\$ 0.09$ | $\$ 0.06$ |
| Total | $\$ 0.15$ | $\$ 1.19$ |


| External costs of smoking - socially financed |  |  |
| :---: | :---: | :---: |
|  | Cigarettes (per pack) |  |
| Medical costs | \$0.26 |  |
| Sick leave/life insurance | \$0.06 |  |
| Nursing homes | -\$0.03 |  |
| Pensions | -\$0.24 |  |
| 81 |  |  |


|  |  |  |
| :--- | :--- | :--- |
|  | External costs of smoking/drinking <br> (per pack) | Heavy drinking <br> (per ounce) |
| Total taxes | $\$ 0.16$ | $\$ 1.19$ |
| $\$ 0.37$ | $\$ 0.20$ |  |

- Dollars values are in real 1986 dollars
- 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 $\operatorname{tax}=\$ 1.48$, Federal $\operatorname{tax}=\$ 1.00$


Why the difference between alcohol and cigs?

- Most of the external costs of alcohol are monetized value of a statistical life
- Value of life is valued at $\$ 5$ million
- Drunk drivers kill 10,000 people/year (other than themselves)
- External costs of $\$ 50$ billion
- DD fatalities have fallen from 23,000 to 10,000 from 1981 to 10,000 - so external costs have fallen a lot
- But real taxes on alcohol have fallen as well

Drunk driving fatalities per 100,000 population decreased 48\% from 1991 to 2010.

Source: rertsa/iars.


Figure 1 Average real Federal excise taxes (in dollars per barrel) on alcoholic beverages 1951-2009.


Figure 2 Average real State taxes on beer tax 1951-2009.

## Value of a statistical life

- 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'
- 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 $\$ 500 \times 10,000=\$ 5$ million in income
- 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


## Drunk Driving Facts

- 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 $2 / 3$ rds 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 $34 \%$

Viscusi (1995)
Costs of smoking

- External insurance costs per pack (1993\$)
- Medical care $\$ 0.388$
- Sick leave $\$ 0.016$
- Group life insuance $\$ 0.072$
- Nursing home care -\$0.062
- Retirement pensions -\$0.286
- Fires $\$ 0.092$
- Total \$0.238
- Taxes paid
$\$ 0.53 /$ pack

What is not included in these numbers?


## 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.
- EPA identifies second hand smoke as a Class I carcinogen
- Surgeon General notes that exposure to second hand smoke at work or home increases risk of heart disease/lung cancer by $20-30 \%$
- California environmental protection agency
- 50,000 deaths annually from second hand smoke

What are some other justifications for higher cigarette taxes

- Recall the market graph. The problem w/ external costs is that people consume above a socially optimal level
- Can be other reasons why people 'over consumer' smoking
- Maybe people do not understand the health risks. If they did, they would not smoke


## Viscusi

- Survey, "of 100 smokers, how many will get lung cancer because they smoke?"
- Survey responses
- Smokers
- Non smokers $\square$
- The true risk level is

- People over state the risk of smoking


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 5 yrs are still smoking

