Review of Last Week

• Problem: Externalities
  – If you don’t pay all the cost or receive all the benefit
  – Of your acts, you will sometimes
    • Do things that reduce efficiency, or
    • Fail to do things that increase it

• Solution: Pigou.
• Critique: Coase
  – Costs and benefits depend on decisions by two or more people
  • So problem is not “I impose costs on you” but
  • We act in ways that don’t maximize our combined benefit
  – Pigou’s solution requires you to know
    • Who should alter what he is doing
    • And that only one person should
  – Alternative (Coasian) approach
    • Define who has a right to do what
    • Then let the parties bargain from there
    • If transaction costs are low enough, they will always get to an efficient result
    • Wherever they start
  • Implications for the law
    – Try to find initial definitions of rights that, averaged over many cases
    – Minimize the costs of getting to the efficient outcome
    – Plus the costs of failing to do so
    – Worked out in agonizing detail for our simple example

Attempts

• Law against attempts a version of ex ante:
  – $10,000 fine for successful offense
  – $5,000 for unsuccessful attempt
  – i.e. $5,000 ex ante for attempting, $5,000 ex post for succeeding.

• Impossible attempts
  – Law specifying what is impossible is a special case of causal link disagreement, makes sense if that level of detail is communicated
  – Law specifying that impossible doesn’t get punished reduces incentive not to try to kill someone.
  – Because you don’t know if the means you plan to use can actually work

Game Theory

• Strategic behavior
  – The problem—other people
  – How do I choose my actions when they are choosing theirs
  – Based in part on what I am doing
  – And the outcome depends on what both of us do

• Not just table games but …
  – Game between attorneys in litigation
  – Between Saddam Hussein and Bush
  – Between parents and children
  – Bargaining over the price of an apple—or anything else

How Economics Avoids It

• Wherever possible, define the problem
  – In a way that eliminates strategic behavior
  – Converts it into a maximization problem
  – Against a fixed environment

• Examples include
  – Perfect competition: Everyone too small to matter
  – Monopoly
    • One player, the monopolist
    • Everyone else responds
    • Without trying to change what the monopolist is doing
    • Because we assume many small customers

• But when all else fails …
Game Theory

- There is a large body of mathematical theory that attempts to
  - Create ways of precisely describing games
  - Create a clear definition of the solution to a game
  - Show how to find it.
- What would the solution to a game mean?
  - A description of how every player
  - Should? Will? Play
  - Typically assuming he plays perfectly
  - Thus chess is a simple and solved game
  - Given infinite computing power
- How can one describe a game?
  - In a sufficiently general way to work
  - For all games

Strategy Matrix: Example

- Scissors/Paper/Stone
- The rules
  - Scissors cut paper
  - Stone breaks scissors
  - Paper covers stone
- Payoff
  - Loser pays winner a dollar
  - No payment in case of tie
- Description: Matrix of strategies and outcomes

Strategy Matrix

- Each player chooses a strategy
  - Player 1 picks a column
  - Player 2 picks a row
- The intersection shows the payoffs to the two players
- What is their sum?

<table>
<thead>
<tr>
<th>Player 2</th>
<th>Scissors</th>
<th>Paper</th>
<th>Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scissors</td>
<td>0</td>
<td>(-1,1)</td>
<td>(1,-1)</td>
</tr>
<tr>
<td>Paper</td>
<td>(1,-1)</td>
<td>0</td>
<td>(-1,1)</td>
</tr>
<tr>
<td>Stone</td>
<td>(-1,1)</td>
<td>(1,-1)</td>
<td>0</td>
</tr>
</tbody>
</table>
Von Neumann solution to a two person zero sum game

- A strategy is a full description of what a player will do in every situation
- Von Neumann proved that for any zero sum two person game
  - There exists a pair of strategies, one for each player
  - If Player 1 plays his strategy, he on average wins at least $V$
  - And if Player 2 plays his strategy, he loses at most $V$
- Doesn't include stealing candy from babies.
  - I.e. strategies that do better than $V$, because
    - They rely on the other player playing badly

What is the VN Solution to Scissors, Paper, Stone?

- If my strategy is paper
  - Scissors always beats it
  - Similarly for each of the others
  - So how can there be a strategy for me
    - So how can there be a strategy for me?
      - That guarantees an outcome better than -1
      - For any strategy of yours
      - And similarly for you?
- Need a mixed strategy. Mine is …
  - Roll a die (where you can't see it)
    - 1,2: Scissors 3,4: Paper 5,6: Stone
    - On average I break even whatever your strategy
      - You follow the same strategy, so …
      - The value of the game is zero for each of us
      - The Von Neumann solution to one very simple game

No Satisfactory Solutions Beyond that?

- Non-fixed sum games
  - Mean that some outcomes
    - Hurt both players
    - Or help both players
  - Making possible threats, bluffs, bargains
    - No threats in a fixed sum game, since
      - If something I can do hurts you it helps me
      - So I would do it anyway
- Multiple player games
  - Bring in coalitions, bargaining
  - Variable sum for the coalition even if fixed sum for all players combined
  - Since we may be able to benefit ourselves at the expense of other players

A number of solution concepts exist

- VN Solution to many player game
  - A set of outcomes such that
    - Any outcome not in the set is dominated by one in the set
    - And no outcome in the set dominates another
  - Where “A dominates B” means
    - A is preferred to B by all the members of a group who
      - Working together could make it happen
    - Three person majority vote: Divide a dollar
      - (1,1,0),(1,0,1),(0,1,1) is a VN solution. But …
      - There are others, some of which
        - Contain an infinite number of outcomes.
- The Core
  - The set of outcomes that no other outcome dominates
    - There may not be any (empty core)
- Nash equilibrium
  - Each player chooses the correct strategy
    - Given what every other player is doing
**Nash Equilibrium**

- Assumes no coalitions
  - Gang of convicts escaping death row
  - One guard with one bullet
  - Surrender is the only Nash equilibrium
  - But if two convicts charge ...
- Assumes “My strategy given what they are doing”
  - Is well defined
  - But consider a firm in an industry with only a few firms
  - Is each firm’s strategy defined as the price it charges
  - Or the quantity it produces
  - Matters when defining what it means for the other firms to keep the same strategy while you choose yours.

**Subgame perfect equilibrium**

- For sequential games
  - View game as a tree diagram
  - Look at the last decision
    - See what the person making it would do
    - Cut off the other branch
    - Move down the tree accordingly
- Consider the “put to bed” game
  - If the child will make good his threat to throw a tantrum and spoil the parents’ dinner party
  - The parent should give in, let the child stay up, but …
  - If the parent doesn’t give in
  - It isn’t in the child’s interest to throw a tantrum
  - So parent knows child won’t throw a tantrum, can put child to bed?
- Not so clear when it is a repeated game
  - And it is
  - Commitment strategies—for both players

**More Games we will Discuss**

- **Bilateral Monopoly**
  - I have the only apple, only you want it
  - Selling it to you produces a one dollar gain
  - If we can agree on a price
- **Prisoner’s Dilemma**
  - My confessing helps me a little, hurts you a lot
  - Your confessing ditto for me, so ..
  - We both confess
  - And are both worse off than if we both stayed silent
Bilateral Monopoly
- A very simple two player non-fixed sum game
  - Hence threats, bargains, bluffs possible
    - "I won’t give you more than $.25"
    - "I won’t take less than $.75"
  - May lead to bargaining breakdown
    - i.e. child does throw a tantrum. Or apple isn’t sold
- Commitment strategy is one way to “win”
- Doomsday Machine as one example
- Hawk/Dove (or Bully/Wimp) a human version
  - The more bullies, the less profitable the strategy
  - In equilibrium, there are just enough bullies to make “Bully” and “Wimp” equally attractive strategies
  - The higher the cost of a bully/bully fight, the fewer bullies it takes to get to equilibrium, hence …
  - “Crimes of passion” may be deterrable!

Bargaining Costs
- Consider bilateral monopoly bargaining as a form of rent seeking
  - I am spending resources trying to get myself a larger share of the gain
  - And you a smaller share
- The more is at stake, the more it is worth spending
  - Setting up commitment strategies
  - Risking expensive bargaining breakdown, in the hope
    - Of getting more if you win
  - Consider the litigation/settlement game
    - In a Coasian world, I sue you for $10,000,000
    - All that happens is that we settle out of court, and
      - One of us ends up richer, one poorer
    - In our world, between us we might spend $5,000,000 on legal costs

Flip Side: The Economics of Virtue
- Why are there people who won’t steal even if they can get away with it?
  - Being known to be such a person
  - Makes you a more valuable partner in voluntary associations, such as
    - Employment
    - Renting
    - Marriage
  - Giving you more than you lose from not stealing
  - Provided people are not natural con men
    - Meaning it's hard to appear honest by nature
    - If you aren’t
- Equilibrium level of virtue
  - The fewer dishonest people, the less the incentive to take precautions
  - Hence the easier to be a successful con man
  - So some equilibrium level of virtue, at which
  - Virtue and vice yield the same reward

Prisoner’s Dilemma
- Two criminals arrested. D.A. tells each
  - Confess, other doesn’t, 1 month
  - Both confess, 1 year
  - Don’t, other does, 2 years
  - Neither, 3 months for disturbing the peace
- It pays each to confess (work it out)
- Simple example of individual rationality vs group rationality
- What about a repeated game?
  - If the number of plays is known, it still works
    - Because it pays to betray on the last play, and
    - Unravels from there
Plea Bargaining

- Does it reduce penalties?
  - Unless the bargain is a better deal than going to trial
  - Why would the defendant accept it?
- Every offered bargain accepted
  - Frees up prosecutorial resources
  - Making conviction more likely for those who don't cop a plea
  - And thus making defendants more willing to accept offered deals
- Each defendant is better off copping a plea, but
  - All defendants might be better off
  - If all of them insisted on going to trial
  - A real world prisoner's dilemma

Implications of Game Theory

- Not rigorous - real world doesn't come with rules, but …
- Suggests the importance of
  - avoiding games with PD structure, or …
  - Getting other people into them
  - For example, getting an army to run away
    - By arranging things so that each soldier
    - Is better off running than standing.
- Suggests the importance of commitment strategies
- Suggests bargaining costs associated with surplus to be divided up.
  - So avoid legal rules with very large bargaining range
  - Such as injunction where the damage is much less than cost of prevention.
  - Compare bargaining cost to litigation cost over damage.
- So gives us a partial handle on transaction costs.

Game Theory Review

- Basic idea: Strategic behavior
- Formal treatments:
  - Von Neumann solution to 2 person fixed game
  - VN solution to many player game
  - The Core
  - Nash Equilibrium
    - Define
    - Swedish switch
    - Escaping prisoners
  - Subgame Perfect Equilibrium
  - None entirely satisfactory

But Helps Us Understand Things

- Bilateral Monopoly
  - Commitment strategies
  - Cost of bargaining
  - And of breakdown
  - Probably scales with amount at stake
  - Commitment leads to a hawk/dove equilibrium
    - Which is a Nash Equilibrium
- Prisoner's Dilemma
  - Shows how individual rationality can fail to produce group rationality
  - Army running away as another example
  - Or traffic jam
- Subgame Perfect Equilibrium
  - Shows how rational people will act
    - In a sequential game
    - Where there are no commitment strategies possible.
Value of Life Matters

- Tort law—damages for tortious loss of life
  - How are they calculated in the law?
  - How should they be?
- Criminal law
  - damage done is relevant to punishment, standard of proof, etc.
  - And some crimes kill people
- Regulation
  - In deciding how safe highways or cars should be
  - How much we should be willing to give up to reduce pollution
  - When new drugs should be allowed on the market
  - One of the relevant costs is measured in lives
  - And must be converted to something else to compare costs to benefits
- Your private decisions
  - How fast to drive
  - What car to own
  - How often see the doctor
  - Whether to give up sky diving

Is life infinitely valuable?

- Judged by private decisions, clearly not
  - We routinely do things that risk death--a little
  - In exchange for other values
- But if someone wants to buy your heart?
  - Turning down his offer shows …
  - Not that your life is infinitely valuable to you
  - But that money is useless to a corpse
  - And people do sometimes accept a near certainty of death, for a benefit to other people they value
- An extreme example of our problem of measuring by dollars
  - Dollars are worth less to rich than poor
  - And much less to dead than alive
  - Making “how many dollars would you give for it”
    - A poor measure of utility
    - In extreme cases
  - Get around the problem by thinking in terms of risks
    - Which is the right answer since
    - Money saved will go to you when alive
    - Or to other people, who are alive to spend it, if you die

Measuring the value of life

- Observe choices people actually make
  - When trading off risk of death
  - Against other values
  - To measure the value of their life to them
- Job premiums in risky professions
  - Assumes those choosing are well informed, and …
  - Ignores the fact that it is a biased sample
    - The people taking those jobs
    - Tend to be the ones with low values for their life
    - So perhaps that gives a lower bound
  - Snow Crash
    - The protagonist is delivering pizza--for the Mafia
    - Which is why he is doing it
    - In that world, pizza delivery is not a boring job
- Willingness to pay for
  - Medical checkups
  - Safer cars…
- Typical estimates are a few million dollars.

Value of life in Tort Law

- Old rule: value of life was zero
  - Because the tort claim for damages was yours
  - And died with you
- Newer rule: Value of your life to other people
  - Loss of your value as a wage earner for your family
  - Loss of consortium
  - So if you have no family or close friends
  - Your life is worthless?
- Hedonic damages: Still pretty academic
  - You have lost the value of the pleasure of the rest of your life
  - That is a cost someone else imposed on you
  - And along Pigouvian lines, even if you can no longer be compensated
  - He can still be charged, to give him the right incentive
Incentives vs Insurance

- Tort damages can be seen both as
  - Compensation for the victim
  - Punishment for the tortfeasor
  - But the optimal values of the two are different

- Consider the loner
  - Why waste his money on life insurance?
    - So if damages are to provide optimal compensation
    - Current law is correct, and his life is worthless
  - Yet he still values his life
    - So we want to give people an incentive not to kill him
    - Which means treating his life as of value

Total utility vs marginal utility

- Losing my eyesight or being crippled
  - Creates new costs—wheelchair, guide dog
  - Lowers my utility even if those are paid
  - May also lower my ability to turn additional dollars into additional utility
    - Because many of the things I used to use money for
    - I can no longer do

- So getting total utility to its old level
  - Even if it is possible
  - Means marginal utility much below its old level
  - So insuring for enough to do that would shift dollars
    - From states of the world where they were more valuable to me
    - To one where they were less
    - So I wouldn’t do it

- The loner losing his life is an extreme example

Tort Damages as Insurance

- “Make the victim whole”
  - Is the right rule for insuring my house, moral hazard aside
  - But the wrong rule for insuring my life, or even my eyes
  - And still wrong even if it is possible

- Optimal insurance
  - Shifts dollars from states of the world where I am rich
  - To ones where I am poor
  - Up to the point where the gain to me from shifting one more dollar
  - Just balances the loss

- If my house burns down
  - Fully compensating me brings me back to my old income
  - Hence the same marginal utility for the last dollar
  - In both states of the world

- What if I get blinded or crippled? Or killed?

Trying to do two things at once

- The right level of insurance
  - Gets marginal utility of income equal
  - Between state of the world where you are not injured
  - And where you are
  - Zero insurance for the loner

- The right level of damages paid
  - Gets your utility ex ante equal
  - Whether the risk is imposed or isn’t
  - Thus charges the potential tortfeasor for the cost he imposes
  - Giving him the right incentive
  - Much more than zero for the loner

- We can’t use tort damages to do both
Tort + Insurance

- Tort is poor insurance anyway
  - Because you want to be insured
  - Whether or not your loss is the fault of someone else
  - And whether or not he has the money to pay
- So use tort damages for the disincentive
  - If you want more insurance than that, buy it
  - But what if you want less?
  - Consider again the loner—do we bury him with the money?
- Let people sell insurance on their lives?
- Let them sell inchoate tort claims
  - “If I am tortiously killed, you get to sue for the value of my life to me”
  - In exchange, you pay me now the expected return from doing so.

Summary

- If we want people to have the correct incentive in imposing risks on others
- The same as in imposing risks on themselves
- Make them liable for the ex post damages
  - Where value of life is calculated as
  - A thousand times what you would accept
  - For a one in a thousand chance of death
- And make damage claims marketable.
- That provides full ex ante compensation
  - My act has a one in a thousand chance of killing you
  - And you can sell your future claim for 1/1000
  - Times the value of your life to you
- Proper disincentive
  - I will only impose the risk if doing so saves me more than it costs you
- And lets people adjust what they actually receive if killed, crippled, etc.
  - On the insurance market
  - In either direction