ECON 522 - SECTION 3-DYNAMIC GAMES AND INTELLECTUAL PROPERTY

I Dynamic Games

Dynamic games are just like static games, except players move sequentially rather than simultaneously. The definition of Nash equilibrium is still the same (everyone is playing a best response), but now we can end up with NE that don't make a lot of sense. In the example from class, a start up firm has to choose "enter" or "do not enter," and the incumbent firm must choose to "fight" or "accommodate." However, we end up with a strange NE in which the new firm chooses not to enter and the incumbent chooses fight, even though the first firm should figure that a rational incumbent firm would never actually fight should the first firm enter the market. Thus we introduced the idea of *sequential rationality*: everyone believes everyone will behave rationally at every point in time. This leads to a "refinement" of Nash equilibrium, which we call *subgame perfect equilibrium (SPE)*, which is just a NE in which everyone is behaving sequentially rationally. We solve these games using *backwards induction*, which just means we start from the end of the game and see what choices people would make if they ever reach those end situations, and we work our way back up to the beginning. You can use this method to solve a lot of strategic interactive games, such as tic-tac-toe, or checkers.

I.1 Back to a static game- the Public Goods Game from class

Setup: There are 100 people with identical preferences represented by: $u = 10\sqrt{X} - x$, where X is the total amount of money (including what that individual contributes) donated for a public park, and x is the amount donated by the individual. Note that just like in the tragedy of the commons example, we can break up the total payment X into how much you pay, x, and how much everyone else pays, $X - x = \underline{X}$. Now we can solve our maximization problem by taking the derivative of our utility and setting it to zero:

$$\begin{aligned} u &= 10\sqrt{X} - x = 10\sqrt{\underline{X} + x} - x \\ \Rightarrow u' &= 10 \times \frac{1}{2}(\underline{X} + x)^{\frac{-1}{2}} - 1 = 0 \\ \Rightarrow 5 &= (\underline{X} + x)^{\frac{1}{2}} \\ \Rightarrow 25 &= \underline{X} + x \end{aligned}$$

Remember from the tragedy of the commons example that we can guess that since everyone has the same utility, then all of the individuals in this society will choose to contribute the same amount, so $\underline{X} = 99x \Rightarrow 25 = 99x + x \Rightarrow x = \$0.25$. The point is that this is not efficient. If everyone contributes \$0.25, then each individual's utility will only be: $u = 10\sqrt{25} - .25 = 49.75$, but they would get more everyone donated \$1 instead (check this). In fact, if we were the benevolent government, we could optimally tax people and provide the public good. The government knows that individuals are the same, so it can set $X = 100x$ and maximize society's utility:

$$\begin{aligned} u &= 10\sqrt{X} - x = 10\sqrt{100x} - x = 100\sqrt{x} - x \\ \Rightarrow u' &= 100 \times \frac{1}{2}(x)^{\frac{-1}{2}} - 1 = 0 \end{aligned}$$

$\Rightarrow 50 = x^{\frac{1}{2}}$

$\Rightarrow 2500 = x$

So the optimal (efficient) amount for each person to donate is \$2500! That's a lot more than \$0.25 (Check to make sure that people actually have higher utility if they are taxed \$2500 a piece to provide the public good). This is an example of how the government can increase efficiency by providing public goods. The reason that public goods are underfunded is that individuals don't internalize the fact that they're imposing *positive* externalities on others when they help supply the public good. This is exactly analogous to the tragedy of the commons example, except in that example individuals weren't internalizing *negative* externalities, thus the result was too much fishing. Another thing to note about this (the public good) example, is that the more people there are in the society, the less each individual wants to donate; it's easier to free ride when there are more people.

II Intellectual Property

- **Private Goods** are *rivalrous* (my *use* prevents your use) and *excludable* (I *can* prevent your use)
  - Usually it's more efficient for private goods to be privately owned. However, sometimes this may not be true. Take our example of smoker's rights. As far as Coase is concerned, assigning the right to smoke to smokers or non-smokers will result in an efficient allocation as long as people can negotiate. The right to smoke-free/smoke-filled air is rivalrous and potentially excludable, but trade may be impossible due to high transaction costs. Thus it may be more efficient for the government to *regulate*, and design what it believes to be efficient smoking rules.
- **Public Goods** are *nonrivalrous* (my use does not prevent your use) and *nonexcludable* (I *cannot* prevent your use)
  - Usually it's more efficient for public goods to be publicly owned. However, sometimes this my not be true. Intellectual property often fits the categories of non-rivalrous and non-excludable (once an idea has been created it's hard to stop someone from using it, and certainly one person's use doesn't preclude another's).

Let's explore the differences between public/private goods some more, and see why intellectual property gives us problems.

First notice that a good being rivalrous does not imply that it's also excludable, or vice versa. Likewise, non-rivalrous does not imply non-excludable. An example of a good thats rivalrous *and* non-excludable (so that it doesn't fall into either the public/private good category) is the fish in the tragedy of the commons example.

Next notice that intellectual property fits the description of a public good, so we should think that it's efficient to for it to be publicly owned/funded, and in fact a lot of it is: right now as students at a public university you are at least partially being funded by the government, and there are many other examples of government funding research and development. However, it may also be efficient to own intellectual property privately, in which case we would need to at least attempt to make it excludable and rivalrous. This is where our four types of intellectual property come in:

(i) **Patents-**property rights over novel, non-obvious, sellable inventions; last 20 years and must be applied for.

(ii) **Copyrights-**property rights for original expression; last 70 years after creator's death and are automatically given upon creation of the expression.

(iii) **Trademarks-**Last until they're abandoned (which is why companies must actively defend their trademarks, much like a land owner must establish use of the land to prevent squatters).

(iv) **Trade secrets-**Protect secrets from being obtained illegally.

Intellectual property	
Type	**Economic Rationale**
Patent Copyright	To align private incentives with social benefit/cost; both assign monopoly rights, but patent monopolies are usually more lucrative
Trademark	Reduce uncertainty about a product
Trade Secret	Set the rules of fair play

Notice that patents last twenty years no matter what, which is probably not the most efficient policy (considering how heterogeneous different industries are, it's likely that different types of inventions should have different patent lengths, but of course figuring out the optimal lengths would be costly). Thus there may be significant dead weight loss from these policies. Another interesting point is that patents give the opportunity for private individuals to compete with the government; even in markets that are traditionally publicly funded, individuals may have some incentive to research on their own (examples are medicine, weapons, and currently space flight).