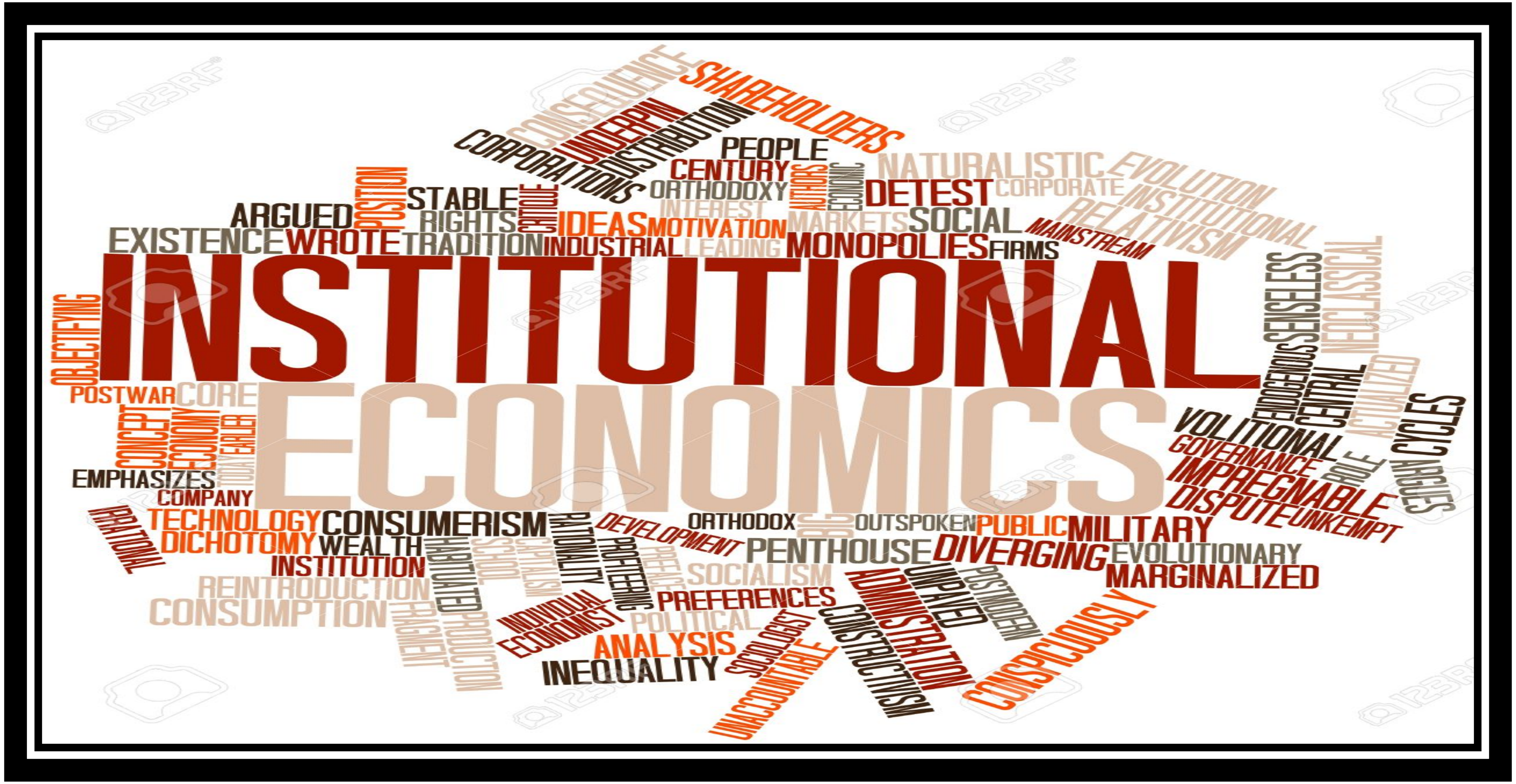


Socrates Majune
skmajune@uonbi.ac.ke

Lecture Four: Property Rights

Order of presentation

1. Announcement
2. Recap
3. Property rights

Property Rights

Journey to Mission MarsInsEcon2023

- Flight is MarsInsEcon-2023
- Vessel id is Mars-Ins-Econ-2023
- Currently in the 4th week of our flight

Introduction

- Property rights have two meanings in economics: legal (or de jure) and economic (or de facto)
- Legal private property rights- Legal or formal property rights are assigned by the state and are “as old as human written records
- Economic property rights - “the right to use goods (or to transfer that right)” so long as other property rights are not adversely affected
- Legal rights are neither necessary nor sufficient for economic rights- They are not sufficient because you may have a legal right that is too costly to enforce (e.g., rights to a chunk of the Pacific Ocean) or norms may prevent exercising your rights, and not necessary because two owners can fully recognize and respect a boundary with a fuzzy legal basis and use the resource efficiently. Furthermore, some owners without legal rights may have de facto rights.

Introduction

- Property rights determine the incentives for resource use
- These are fundamental institutions that determine who can do what with different resources
- Property rights, describe the relationship between the owner and others. So rights deal with relations between persons, not relations between a person and property
- Property rights consist of the set of formal and informal rights to use and transfer resources
- They are legal provisions either written in existing codified laws or simply part of people’s mental programming where each right would have been hard wired
- Property rights range from **open access to a fully specified set of private rights**
- By open access we mean that anyone can use the asset regardless of how their use affects the use of others

Introduction

- In a firm set-up, ownership rights matter in future negotiations if contacts are incomplete
- Property rights can be complete, meaning all attributes of the thing are owned and not in the public domain; and they can be perfect, meaning that the actual choice is fully manifested. Transaction costs are defined with respect to perfection
- Property-rights assignments in the sense of exclusive individual rights to physical objects are absolute rights
- Absolute property rights are directed against all others (as, e.g., property in land or other tangibles) but they also include intangibles such as copyrights and patents
- Relative property rights, on the other hand, give the owner "a power which he/she can exercise only against one or more determined persons"

Ingredients of Property Rights

- A full set of private rights consists of the following

1) The right to use the asset in any manner that the user wishes, generally with the *caveat* that such use does not interfere with someone else's property right;

2) The right to exclude others from the use of the same asset

3) the right to derive income from the asset;

4) the right to sell the asset

5) the right to bequeath the asset to someone of your choice

- In between open access and private property rights are a host of commons arrangements
- Under a commons arrangement only a select group is allowed access to the asset and the use rights of individuals using the asset may be circumscribed
- For example, a societal group, e.g., a village, tribe or homeowner's association, may allow its members to place cattle in a common pasture but limit the number of cattle that any member may put on the commons

General forms of Property rights

1. Claims Rights or the right to control other peoples rights. Can of course be outcomes of norms through which people relinquish the right of control of their actions to others
2. Liberty rights or the right to act in specific ways

❖ Each of these can be seen as a bundling of rights such as

a) Use rights or usufruct right which translate to control of the use of given property
b) Extraction rights or the right to capture the benefits from property through either farming or mining
c) Transfer rights or the right to sell or lease property to someone else.
d) Exclusion rights or the right to exclude other parties from use and transfer of rights over property
e) Encumbrance rights or the right too use property to as security or for other declared purposes

Property Rights: Dynamics

- One role of the state is to define, interpret and enforce property rights
- Definition of property rights is a legislative function of the state
- Interpretation of property rights is a judicial function of the state
- Enforcement of property rights is a police function of the state
- All three functions entail costs and for this reason some rights may be left by the state as open access
- Moreover, many assets have multiple dimensions and it is costly for the state to define property rights over all valuable dimensions and costly for the state to enforce property rights over all dimensions
- As such, some attributes may be either *de jure* or *de facto* left as open access
- Individuals and groups have incentives to expropriate the use rights over attributes that the state leaves as open access
- In many situations individuals or groups use violence as a strategy to capture property rights

Fundamental attributes of property rights

- Property rights are essentially about relationships of people with regard to a thing and its benefit streams
- For example, when the author of a book receives a copy right over the book, he or she simply defines his/her relationship with other people with regard to the use of the book. When a landlord receives title over a piece of land, that title simply defines the relationship between him/her and other people with regard to the piece of land.
- In other words, property rights are essentially relational
- There are as many private worlds on the distribution of rights as the number of people, each person holding a mental picture of how rights are distributed. Such mental pictures are uniquely personal that gets occasional accosted by other peoples' mental pictures about rights

Example

- Consider for example a room shared by smokers and non-smokers. There are only FOUR possibilities regarding perceptions about rights are shown in the table below

Smokers' perceptions about who holds the smoking rights	Non-Smoker's perception about who holds the right over smoking	
	1	2
	3	4

Cell Number	Perceptions about how holds rights over smoking		Potential Actions
	Smokers	Non-smokers	
1	Smokers	Smokers	Smoker can choose to light up, nothing happen
2.	Smokers	Non - smokers	Smoker confidently lights up. Non smoker protests, a dispute ensues
3	Non-smokers	Smokers	Smoker will not light up unless they first seek permission from non-smoker, who will point out that the smoker already has the right to smoke
4	Non-smokers	Non-smokers	Smoker doesn't light up except he/she first seeks permission from the non-smoker who will either grant or deny

Example: Cont…

- Actions precipitated by perceptions under cells 2 and 3 are most revealing about the essential character of rights. They indicate that perceptions about rights are not necessarily universal
- A market system is defined by a property rights based exchange, which must co-exist with a political system that defines and enforces property rights
- For this reason, market systems are never closed systems because they have to interface with political systems
- Property rights are therefore social institutions that define and limit the range of privileges granted to individuals over specific resources
- Ownership of such resources involves a variety of rights, such as the right to exclude non-owners and the right to appropriate streams of economic rents from the resources, the right to sell or transfer the resource to others

The role of property rights

- ❖ Property rights matter because they determine resource use
- ❖ The more exclusive are property rights to the individual or group the greater the incentive to maintain the value of the asset
- ❖ Furthermore, more exclusive rights increase the incentive to improve the value of the asset by investment e.g. in the case of land this may entail the removal of rocks and stumps or using fertilizers
- ❖ In this situation, the ability to invest is aided if assets can be used as collateral to secure a loan
- ❖ Allowing sales as a property right may improve resource allocation in two ways:

1) They signal scarcity value
2) Markets enable those who value the asset most the ability to purchase the asset

- To be meaningful, property rights need to be enforced
- One of the critical roles of the state is to enforce property rights
- Enforcement by the state typically lowers self-enforcement costs which raises the value of the asset directly but also via the incentive for increased investment
- A further impact of state enforcement is that asset holders can reallocate their labour from defending their asset to household or market production

The role of property rights-Cont…

- Property rights are vital to three central NIE issues: (1) incentives; (2) transactions; and (3) contracts and firms
- Property rights are central to NIE because they define incentives for resource use, production, investment, and trade
- Transactions are about the transfer of rights to use a resource, which is central to the operation of a market economy. The more complete are property rights, the lower are transaction costs and the higher the gains from exchange
- Contracts and firms- the owner of a factor of production has the choice of "(1) producing and marketing goods himself, (2) selling his input outright [on the market], or (3) entering into a contractual arrangement surrendering the use of his input to an agent in exchange for an income"

Where do Property Rights Come From?

❖ There are multiple sources, leading to multiple legal orders or legal pluralism or overlapping legal orders.

1. International treaties and laws
2. The state through statutory law, established religious laws and acceptable religious practices
3. Customary law
4. Project and donor laws including project regulation
5. Organizational laws

Criteria for the efficiency of property rights

1) Universality or the fact all scarce resources are owned by someone so that rights over resources are universal
2) Exclusivity – the property rights are exclusive and not shared
3) Transferability – so that resources can be progressively transferred from low to high yielding uses

- Such efficiency is assumed to obtain at least in the long run

- ❖ How property rights are defined and enforced affects economic performance for at least two reasons

1. Assigning ownership to resources defines who draws economic rewards and who bears the cost of resource use. For this reason, property rights structure incentives for economic behavior in a society
2. Property rights allocate decision making, so that property rights regimes determine key actors in the economic system

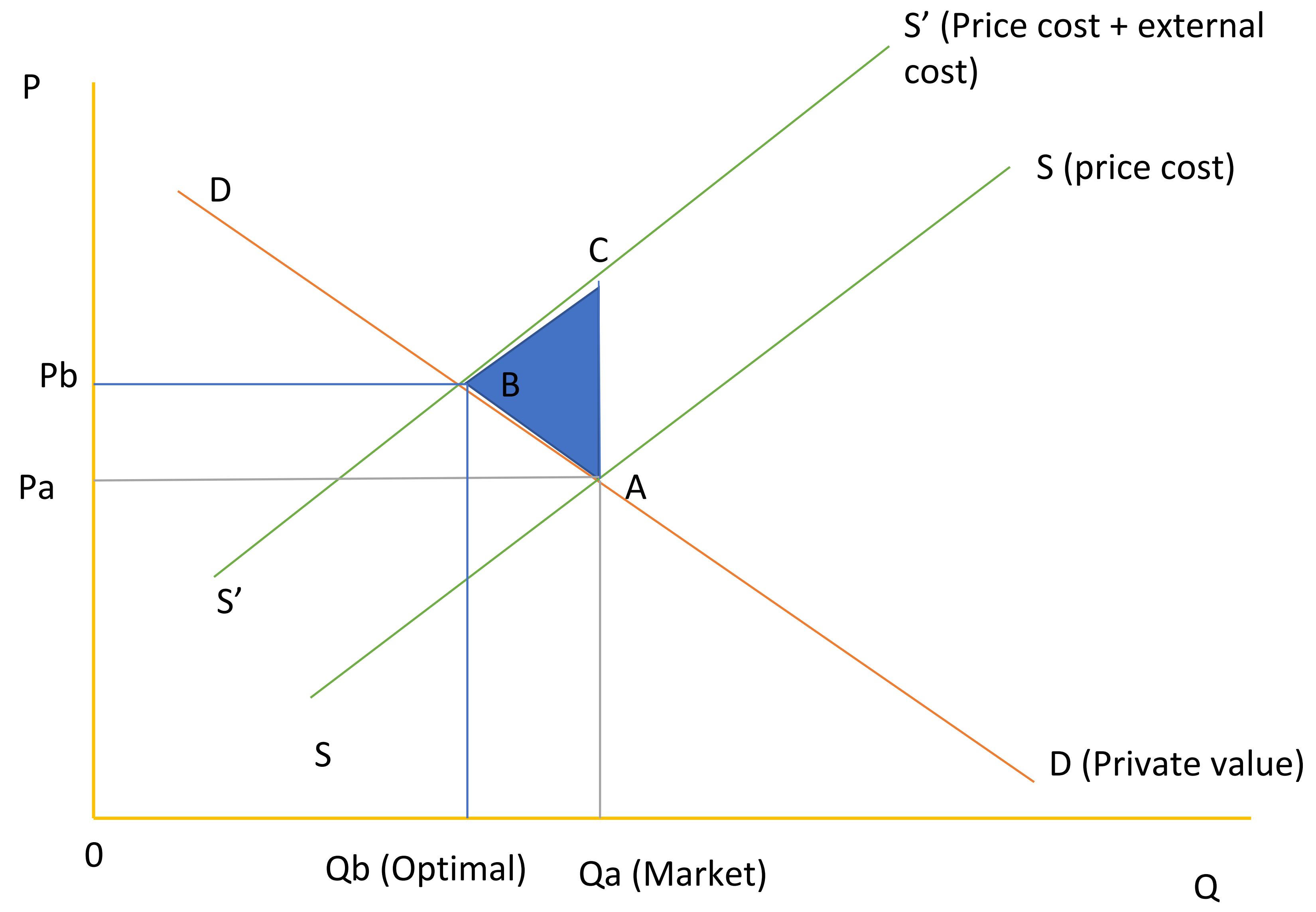
Coase Theorem

- ❖ Based on his seminal 1960 work on The Problem of Social Cost
- ❖ The theorem states that if trade in an externality is possible and there are sufficiently low transaction cost:
- ✔ **Broad Interpretation:** then parties will arrive at a Pareto efficient outcome regardless of which owns the property rights through bargaining
- ✔ **Narrower interpretation:** …then the allocation of resources will be efficient and invariant with respect to the legal rules of entitlement
- ❖ Externality= social cost
- ❖ It is the presence of transactions costs that makes property rights important for effective distribution of resources and meaningful exchange

Coase Theorem

- Consider the issues raised by something as commonplace as a building plot. Its borderlines can be determined with great precision at relatively low cost. The space above (and below) the surface of the plot also belongs to the landowner, but here a more serious specification problem arises. Clearly, the air in the space above the plot cannot be assigned, molecule by molecule, to the exclusive use of the landowner. What the state can do instead, for example, is to give the owner the right to apply for an injunction to rule out the creation of smoke, noise, smells, or other external effects in his immediate neighborhood
- This approach is not the only possible solution, however. The state may assign rights in the opposite fashion and give the neighbors the right to pollute the air or be noisy. Nevertheless, whatever the assignment of rights turns out to be, if zero transaction costs are assumed, individuals will (ideally) trade some of their rights away until a Pareto-efficient allocation of resources has been realized

- The important "discovery" of Coase was to point out that the right to clean air and quiet and the right to undertake activities that generate harmful effects are property rights and are thus completely parallel with other rights that go with property ownership (such as the right to till land or cut timber)
- Such rights can be given away or sold to another party just as any other good can. And transfers can be anticipated
- In general, gains can be achieved through exchange, and thus people will often find it advantageous to trade their rights to such things as clean air and quiet for money
- *Quick quid plantatur solo solo cedit* "whatever is affixed to the soil belongs to the soil"


S’ (Price cost + external cost)
P
S (price cost)
D
C
Pb
B
Pa
A
S’
S
D (Private value)
0
Qb (Optimal)
Qa (Market)
Q

Example

- Piano lessons
- Problem
  - Friend likes playing piano
  - Plays at home every day
  - Neighbour does not like music
  - Therefore this is a bother to the neighbour
  - Negative externality (noise)
- solution
  - What to do? Your friend forgets about the piano because of the neighbour? Or the neighbour gets used to it? Or can they comprise?

- Cost
  - Friend: Playing the piano (Kshs 10,000)
  - Neighbour: likes his peace and silence about (Kshs 15,000)
  - So the neighbour can request your friend to stop playing the piano and be compensated (between kshs 10,00-15,000)
  - Both will be happy (this is an efficient outcome)

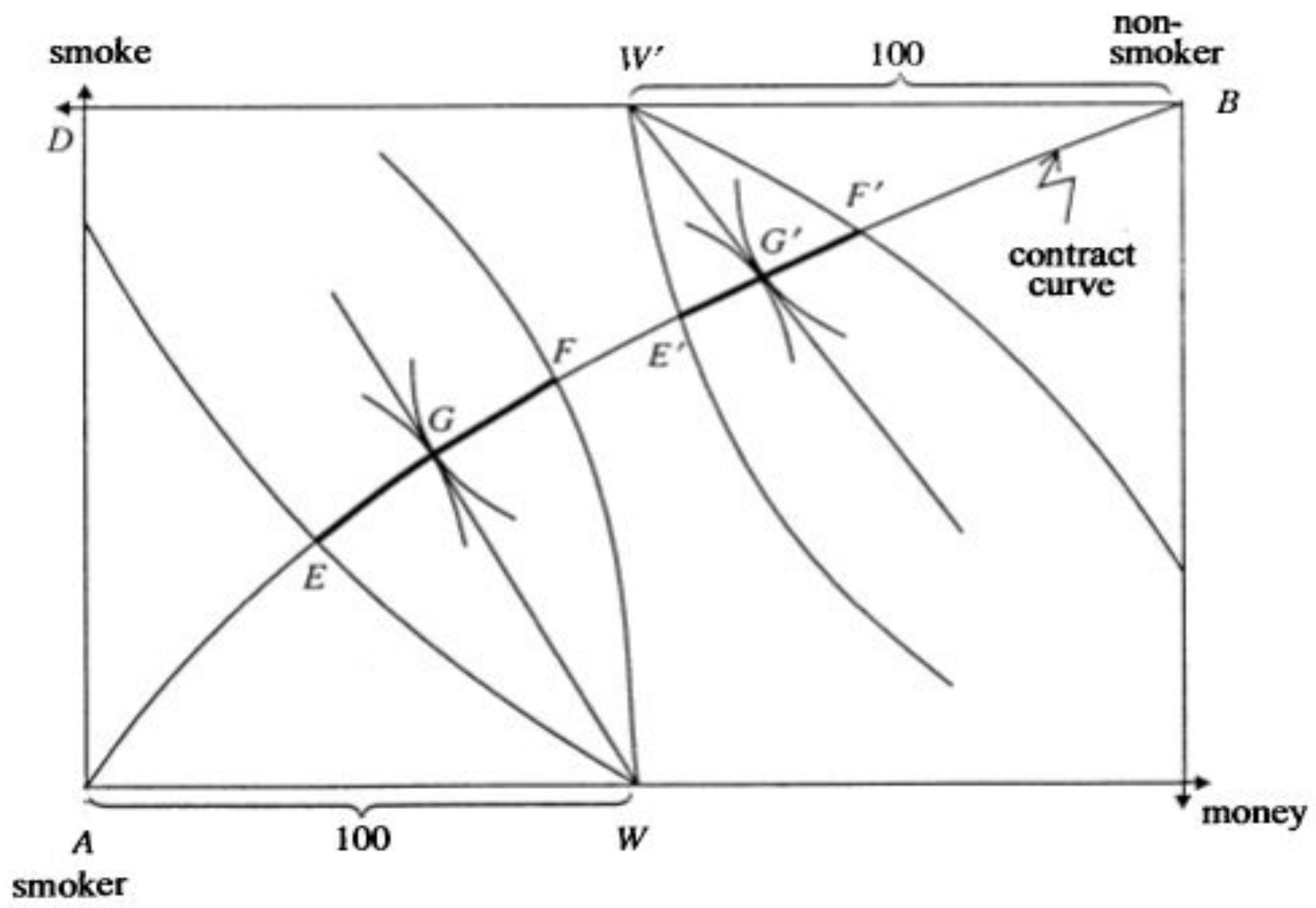
- Who has the property right?
  - Friend (the right to play the piano whenever he/she wants)
  - Then the neighbour will compensate him/her if she stops the piano
  - If the neighbour has the right to enjoy silence (the friend will pay the neighbour to play the piano)
  - Coase(Friend and the Neighbour can bargain with out cost)

Example

- From Varian "Intermediate Microeconomics" 8th Edition, 2010
- Assume two roommates A and B
- A and B, who have preferences over "money" and "smoke."
- Both like money, but that A likes to smoke and B likes clean air
- We can depict the consumption possibilities for the two consumers in an Edgeworth box. The length of the horizontal axis will represent the total amount of money the two agents have, and the height of the vertical axis will represent the total amount of smoke that can be generated. The preferences of agent A are increasing in both money and smoke, while agent B's preferences are increasing in money and clean air
- We will measure smoke on a scale from 0 to 1, where 0 is no smoke at all, and 1 is the proverbial smoke-filled room
- Assume that each decision maker has an initial endowment of $100

Example

- A’s money is measured horizontally from the lower left-hand corner of the box, and B’s money horizontally from the upper right-hand corner
- The total amount of smoke is measured vertically from the lower left-hand corner. The difference occurs because money can be divided between the two consumers, so there will always be two amounts of money to measure, but there is only one amount of smoke that they must both consume
- In this example, B is better off when A reduces his consumption of smoke since both agents must consume the same amount of smoke and smoke is a bad for agent B

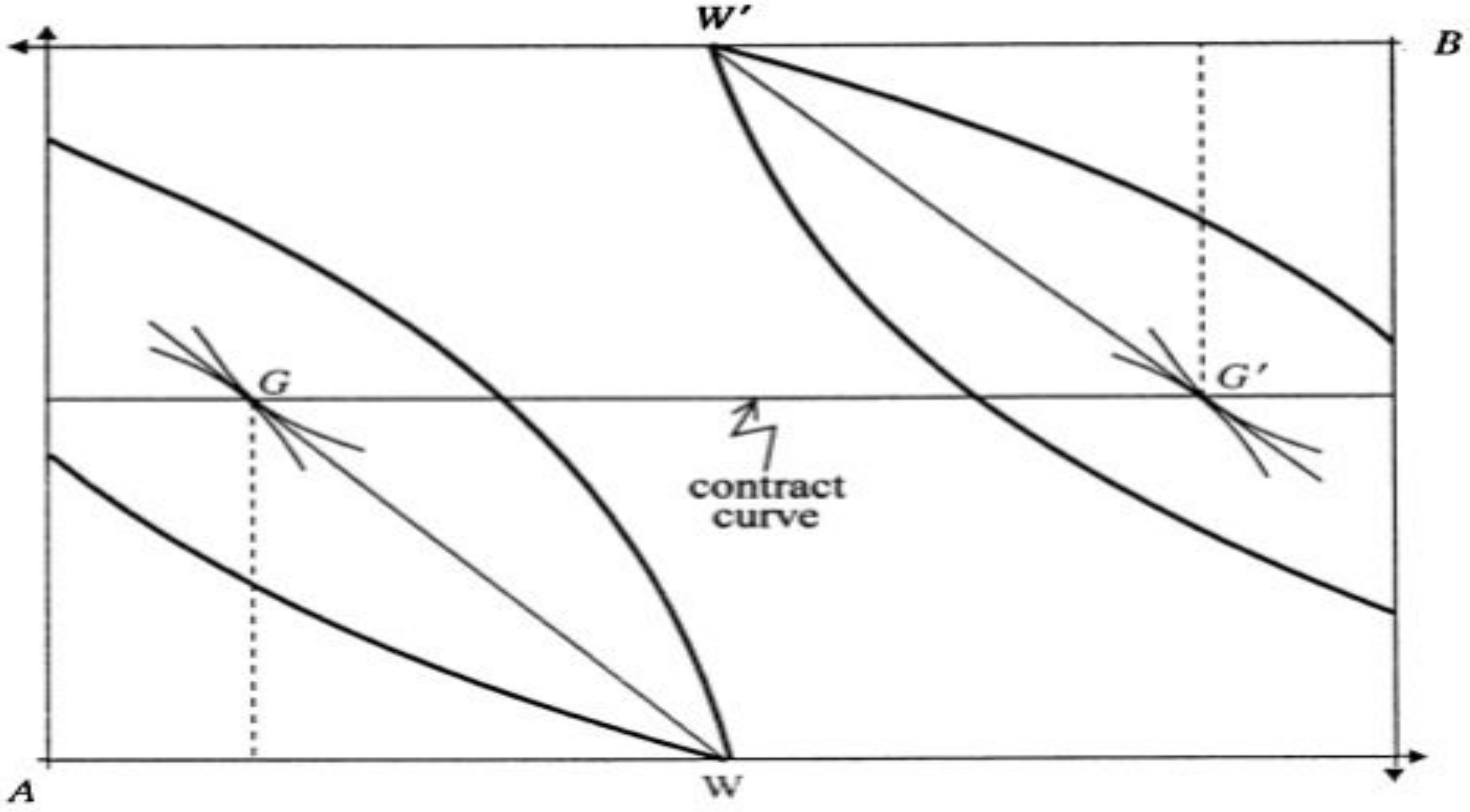


Preferences for money and smoke. Smoke is a good for person A but a bad for person B. Which equilibrium we end up at depends on which endowment we start at. The difference occurs because money can be divided between the two consumers, so there will always be two amounts of money to measure, but there is only one amount of smoke that they must both consume

- The initial endowment of smoke depends on the legal system
- To say that A has an initial endowment of $100 means that A can decide to consume the $100 him/herself, or he/she can give it away or trade it to any other individual. There is a legal definition of property involved in saying that a person “owns” or “has a right to” $100
- Similarly, if a person has a property right to clean air, it means that he/she can consume clean air if he/she wants to, or he/she can give it away or sell that right to someone else. In this way, having a property right to clean air is no different from having a property right to $100
- Assuming that the non-smoker (person B) has the legal right to clean air
- The point of departure for analysis, then, is point W where the quantity of smoke is zero and each individual has $100. This means that both A and B have $100, and that the initial endowment—what there would be in the absence of trade—is clean air
- If B, would be willing to trade away some of his/her property right to clean air for money and in this way increase his/her satisfaction level (relative to point W, the lines through this point represent the indifference curves of A and B). Insofar as exchange of this type is initiated, the two roommates would end up with an exchange equilibrium at some point on the contract curve between E and F say, at point G

- The outcome of the externality situation is different if the smoker (A) has the property right to create smoke and pollute the air up to the amount AD. If, again, A and B have initial money endowments of $1 00 each, then the point labeled W' in the diagram indicates the amounts of the respective "commodities" that individuals A and B possess before exchange begins
- In this case the smoker would be willing to trade some of his/her rights to create smoke for money. The nonsmoker (B) could, in effect, "bribe" the smoker (A) to reduce his/her creation of smoke. Each party would improve their welfare by moving from point W' to some point on the contract curve between E' and F' such as G'
- In general, if there is a market for smoke, a competitive equilibrium will be Pareto efficient
- Recall that a pareto efficient allocation is one where neither consumer can be made better off without the other being made worse off. Such an allocation will be characterized by the usual tangency condition that the marginal rates of substitution between smoke and money should be the same between the two agents
- As long as there are well-defined property rights in the good representing the externality (no matter whether, e.g., the smoker or the nonsmoker possesses the right), the individuals can trade from their initial endowments to a Pareto-efficient allocation
- One mechanism that they could use to trade is the price mechanism, specifically auctioneering

- Problems arise, however, if the property rights are not well defined: "If A believes that he/she has a right to smoke and B believes that he/she has the right to clean air, we have difficulties
- Ideally, if property rights are well defined, trade between agents would result in an efficient allocation of the externality
- In its "strong" form, the Coase theorem asserts that the initial assignment of property rights or legal entitlements makes no difference to efficiency because identical Pareto-optimal allocations will emerge regardless of whether the party generating an adverse externality does or does not bear legal liability for the damages he causes to others
- There is, of course, acknowledgment that, in order for this interesting outcome to be realized, some very far reaching assumptions have to be made
- The key requirements cited in the literature are: (1) costless negotiation, (2) fully defined property rights, and (3) the absence of wealth effects
- In this special environment, ***transaction costs are zero and the negotiating parties have quasi -linear preferences***, then every efficient solution must have the same amount of the externality
- The quasilinear preference assumption implies that the demands for the good causing the externality doesn't depend on the distribution of income. Therefore a reallocation of endowments doesn't affect the efficient amount of the externalities
- If, in addition, certain problems posed by strategic behavior and free riding are ruled out, it is said that efficient bargaining can go forward and the level of an externality will be set optimally



Quasilinear preferences and the Coase theorem. If each consumer's preferences are quasilinear, so that they are all horizontal translates of each other, the set of Pareto efficient allocations will be a horizontal line. Thus there will be a unique amount of the externality, in this case smoke, at each Pareto efficient allocation

- Allocative results are independent of the assignment of property rights if we assume individuals A and B possess quasi-linear preferences
- In the circumstances envisioned, the contract curve is a line parallel to the money axis of the Edgeworth
- The implication of this condition is that every efficient solution has the same amount of the externality. What remains, of course, is a distributional problem
- Just as in the first case studied, the nonsmoker will end up with a larger amount of money than their initial endowment if the right to clean air is allocated to them and with less money if the smoker has the right to create smoke. For the smoker, the opposite would be true
- The result that under certain conditions the efficient amount of the good involved in the externality is independent of the distribution of property rights is sometimes known as the Coase Theorem

[Congestion as a negative externality] There is a large number of commuters who decide to use either their car or the tube. Commuting by train takes 70 minutes whatever the number of commuters taking the train. Commuting by car takes $C(x) = 20 + 60x$ minutes, where x is the proportion of commuters taking their car, $0 \leq x \leq 1$.

(a) Plot the curves of the commuting time by car and the commuting time by train as a function of the proportion of cars users. Then determine each traveller's decision $d(x)$ on whether to use the car or the tube as a function of car time $C(x)$.

(b) What is the proportion of commuters who will take their car if everyone is taking her decision freely and independently so as to minimize her oun commuting time?

(c) What is the proportion of car users that minimizes the total commuting time?

(d) Compare this with your answer given in part b. Interpret the difference. How large is the deadweight loss from the externality?

(e) Explain how a toll could achieve the efficient allocation of commuters between train and car and the beneficial for everyone.

Solution:

(a) The commuting times for tube and cares are shown in the figure.

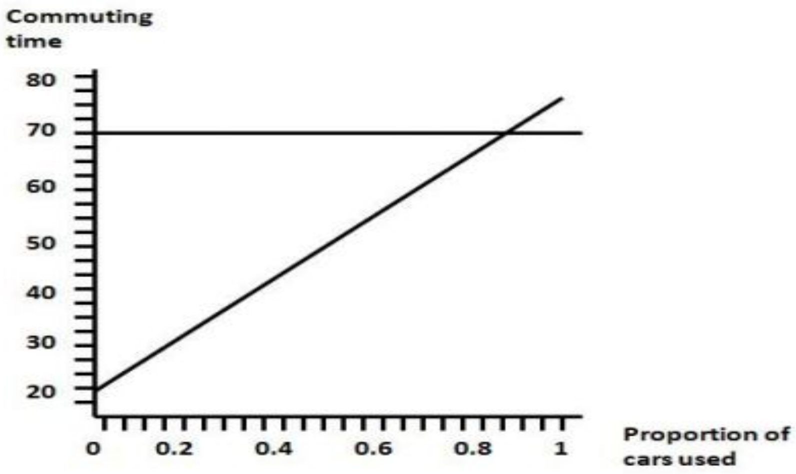


Figure 1. Commuting time.

The time by tube is constant, but the time taken by car, $C(x)$, increases as car use increases. Every traveller's decision $d(x)$ can be expressed as

$$d(x) = \begin{cases} \text{car} & \text{if } C(x) \leq 70, \text{ or} \\ \text{tube} & \text{if } C(x) > 70 \end{cases}$$

(b) The proportion of car users , if independent choices are made, will be such that the times of travel by tube and by car are equated.
Thus, $70 = 20 + 60x_m$ solving for x_m gives $x_m = 5/6 = 0.833$. This solution corresponds to the intersection point of the two commuting time courves.

(c) The total commuting time is $(20 + 60x)x + 70(1 - x)$, where x is the proportion of car users. Setting the derivative with respect to x equal to zero gives: $20 + 120x - 70 = 0$ or $120x_o - 50 = 0$ thus $x_o = 5/12 = 0.416$ is the time-minimizing car use.

(d) The free-market outcome for the proportion of car users is greater than the socially optimal outcome because the individual commuters do not take into account the negative externality generated by car travel, meaning the traffic congestion. The deadweight loss from the externality is the difference between the total commuting times. Using the earlier results obtains

$$T_m = \underbrace{\left(20 + 60\left(\frac{5}{6}\right)\right)\left(\frac{5}{6}\right)}_{\text{car}} + \underbrace{70\left(\frac{1}{6}\right)}_{\text{tube}} = \tfrac{420}{6} = 70$$

and

$$T_o = \underbrace{\left(20 + 60\left(\frac{5}{12}\right)\right)\left(\frac{5}{12}\right)}_{\text{car}} + \underbrace{70\left(\frac{7}{12}\right)}_{\text{tube}} = \tfrac{715}{12} = 59.58$$

The difference is $T_m - T_o = 70 - 59.58 = 10.41$.

(e) Suppose that the commuters attach monetary value to their travel time. It takes 45 minutes per car user, and 70 per train user. Then a toll that is worth 25 minutes of commuting time may induce car users to switch from car to tube because the amount of the toll exceeds the benefits of a shorter travel time. Given information on the monetary value of travel time, the amount of the toll can be computed so that the proportion of commuters that still find it beneficial to travel by car is exactly equal to the socially optimal level.

Question Four

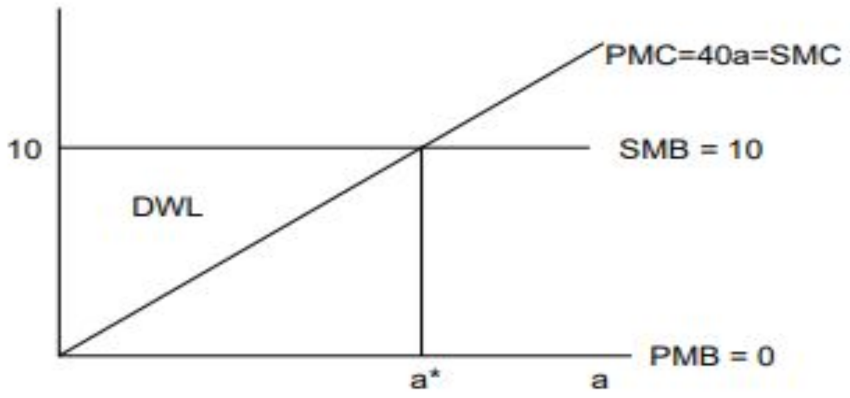
Vermont Hardwood crafts solid wood furniture using a combination of time-tested hand construction and modern finishing techniques. Residual wood finishing chemicals are washed away as run-off and deposited in the nearby lake, a favorite fishing site for locals. A variety of technologies, including high volume, low pressure sprayers and on-site solvent recovery sills are available for implementation. These technologies allow the manufacturer to reduce chemical emissions at a cost:

$$C_1(a) = 20 \cdot a^2$$

where a is the level of pollution abatement. A city planner determines that the benefit to the residents of pollution abatement is 10 per unit.

1. Sketch a graph depicting the private marginal costs and benefits of abatement, and label the private market equilibrium. On the same set of axis, sketch the social marginal costs and benefits of abatement, and label the efficient outcome. Indicate the DWL if the city takes no action.

- The private marginal benefit is zero. The private marginal cost is $mc = 40a$.



2. Calculate the level of pollution abatement that is socially efficient.

   - SMC=SMB when $40a = 10$, or $a = \frac{1}{4}$.

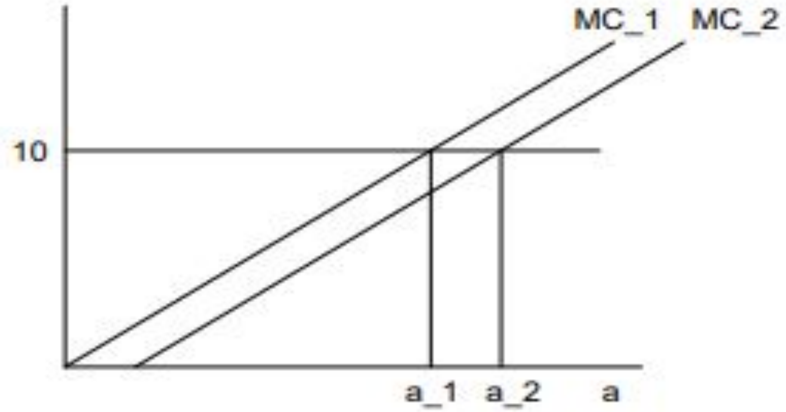
3. If the city institutes a per-unit tax on chemical emissions, what specific tax (τ^*) will reach the socially optimal amount of abatement?

   - The city should choose $\tau^* = 10$.

The city planner is considering either taxing the firm's pollution or requiring the firm to reach a minimum level of pollution abatement. However, given constant progress in abatement technologies the costs of abatement *might* reduce to: $C_2(a) = 20 \cdot a^2 - a$. Thus while the social benefits of abatement are known, the social costs are uncertain.

4. Suppose that the planner institutes the per-unit tax calculated in (b). Assume that the true costs of abatement are revealed as $C_2(a) = 20 \cdot a^2 - a$. Illustrate the problem graphically and indicate the DWL relative to the social optimum. What level of abatement will be undertaken by the firm? Calculate the DWL.

   - We have $MC_2 = 40a_2 - 1$. Now, the firm will choose $40a_2 - 1 = 10$, or $a_2 = \frac{11}{40}$. There is no deadweight loss. The firms adjust to the social optimum in response to the taxation.



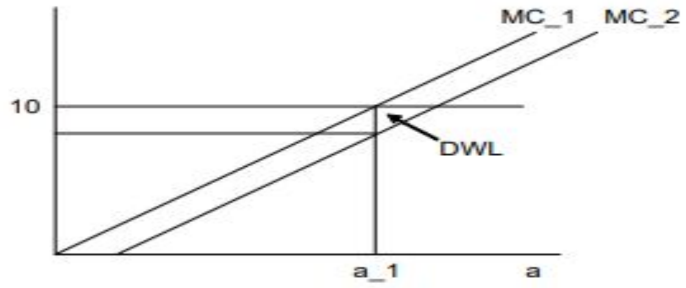
5. Suppose instead that the planner institutes a mandatory minimum abatement at the socially optimal level found in (2). Again, assume that the true costs of abatement are revealed as

$C_2(a) = 20 \cdot a^2 - a$. Illustrate the problem graphically and indicate the DWL relative to the social optimum. What level of abatement will be undertaken by the firm? Calculate the DWL.

- In this case, the firm abates $a = \frac{1}{4}$ when the socially optimal level of abatement is $\frac{11}{40}$. Total welfare under the socially optimal case is $\frac{11}{40}9 - 20\left(\frac{11}{40}\right)^2$. Total welfare when abatement is $\frac{1}{4}$ is $\frac{1}{4}9 - 20\left(\frac{11}{40}\right)^2$, yielding a DWL of

$$DWL = \frac{11}{40}9 - 20\left(\frac{11}{40}\right)^2 - \left(\frac{1}{4}9 - 20\left(\frac{11}{40}\right)^2\right)$$

as shown in the graph:



6. Given the uncertainty in abatement costs, which strategy makes the most sense for reducing pollution in this context?

   - Taxation is better than quantity mandates is better

7. Intuitively discuss what is driving this result.

   - Price controls are better than quantity regulation when the SMB curve is relatively flat (relative to the SMC curve). Setting a "price" allows one to get "closer" to the true social benefit when the social benefit curve is flat. If it's steep, then using quantity regulation allows one to get close to the true social benefit. In some sense, a flat SMB curve allows one to be relatively more confident in the level of the tax as opposed to the quantity of the abatement.

An natural gas company in San Francisco owns many pipelines running underneath what is now populated areas. The company can invest \$$u$ in the maintenance of the pipes. Maintenance affects two things. First, more maintanence means that the gas company will lose less gas in the pipes. Assume that the value of lost gas is given by $\frac{1}{u}$ so that more maintenance reduces the amount of lost gas. Second, more maintenance means less damage to the land above the pipes. Assume that value of the damage to the land above the pipes is given by $3 \cdot \frac{1}{u}$, so that more maintenance decreases the amount of damage to the land above.

1. What is the socially optimal level of maintenance, u? What is the value of lost gas? What is the value of land damage?

   - The social optimum minimizes total costs:

     $$\min u + 3\frac{1}{u} + \frac{1}{u}$$

     or

     $$1 = 4\frac{1}{u^2} = 0$$

     or

     $$u^s = 2$$

     The socially optimal amount of maintenance is $u^s = 2$. The value of lost gas is $\frac{1}{2}$ and the value of land damage is $\frac{3}{2}$.

2. What level of u is chosen by the gas company when no one owns the land above the pipes? Now what is the value of lost gas? What is the value of land damage? What is the deadweight loss?

   - The gas company will solve
   $$\min u + \frac{1}{u}$$
   so that
   $$\frac{1}{(u^p)^2} = 1$$
   or $u^p = 1$. The value of lost gas is 1 and the value of land damage is 3. The total social costs are therefore $1+1+3=5$. In the social optimum, the social costs are $2+\frac{1}{2}+\frac{3}{2}=4$. Therefore, the deadweight loss is $5-4=1$.

3. Suppose now that the gas company owns the land above the pipes. What level of u will they choose now? Is this optimal? If not, calculate the deadweight loss.

   - Gas company will mimize costs that include the damage to the land:
   $$\min u + 3\frac{1}{u} + \frac{1}{u}$$
   and choose $u^p = u^s = 2$, which is optimal. There is no deadweight loss.

4. Suppose now that Jimmy Fallon, an ordinary private citizen, owns the property above the plant and can costlessly sue the natural gas company for the losses to his property. What level of u will be chosen by the natural gas company? How much will be paid from the gas company to Jimmy Fallon?

   - Jimmy Fallon's lawsuits impose a cost on the gas company of $P(u) = 3\frac{1}{u}$. They will take this into account in their choice of u, choosing to minimize:
   $$\begin{aligned} & \min u + \frac{1}{u} + P(u) \\ = \quad & \min u + \frac{1}{u} + 3\frac{1}{u} \end{aligned}$$
   Therefore, they choose $u = 2$, the social optimum. The gas company will pay Jimmy $\frac{3}{2}$ for his property damage.

5. Suppose now that the courts are imperfect: For every $1 in actual damage, only 50% of the damage can be recouped in court. So, if the true damage to Jimmy is L, the gas company will only pay $\frac{L}{2}$.

   (a) Suppose Jimmy Fallon owns the property. What level of u will be chosen by the gas company? Is this efficient? If not, what is the deadweight loss?

- In this case, the gas company only pays $P(u) = \frac{1}{2}\left(3\frac{1}{u}\right)$. Therefore, they minimize

$$\min u + \frac{1}{u} + \frac{1}{2}\left(3\frac{1}{u}\right)$$

or

$$1 - \frac{5}{2}\frac{1}{u^2} = 0$$

or

$$u = \sqrt{\frac{5}{2}}$$

This is not efficient ($u < 2$). The total social costs are now

$$\sqrt{\frac{5}{2}} + 4\frac{1}{\sqrt{\frac{5}{2}}}$$

so that the deadweight loss is

$$4 - \left(\sqrt{\frac{5}{2}} + 4\frac{1}{\sqrt{\frac{5}{2}}}\right)$$

   (b) Suppose the gas company owns the property. What level of u will be chosen? Is this efficient? If not, what is the deadweight loss? If your answer is different than in (a), why? Have we violated an assumption of the coase theorem?

- This is the same as in part (3). The solution is efficient. The 50% recoup rate imposes a transactions cost, which violates the assumptions of the coase theorem.

There are 150 hunters in a community. They each choose whether to hunt in the forest or on the plains. The plains are so large that each hunter can catch 0.05 tons of game no matter how many other hunters are there. The forest can get crowded, however. If there are x hunters in the forest, each of them catches $\frac{1}{2}x^{-\frac{1}{2}}$ tons of game (so, in total, $x * \frac{1}{2}x^{-\frac{1}{2}} = \frac{1}{2}x^{\frac{1}{2}}$ tons of game are hunted in the forest). Forest game and plains game are perfect substitutes in consumption and there are no other costs associated with hunting in the forest or the plains. The demand for game is perfectly elastic at price \$5 per ton. *(Note: You can ignore discreteness throughout the question.)*

1. **(5 points)** If each hunter is free to choose whether to hunt in the forest or the plains, how many hunters will go to the forest, how many to the plains, and what will be the average yield for the 150 hunters?
Hunters will hunt in the forest up to the point where they are indifferent between hunting in the forest and hunting on the plains, i.e. the point at which a hunter obtains the same yield from hunting in the forest and

on the plains. In equilibrium:

$$\begin{aligned} \frac{1}{2}N^{-\frac{1}{2}} &= 0.05 \\ N &= 100 \end{aligned}$$

There will be 100 hunters in the forest, and 50 hunters on the plains. The average yield is the same for everyone, and is equal to 0.05.

2. **(3 points)** What is the nature of the externality in this example? Using the Coase Theorem, analyze why the market does not internalize this externality.
   Dissipative externality. The extra hunters do not take into account the congestion they are causing in the forest when deciding whether or not to "enter". There are no property rights assigned. Given the high number of parties involved, bargaining is likely to be costly, hence by the Coase theorem the market will not internalize this externality and the market equilibrium will be inefficient.

3. **(5 points)** If the government restricts access to the forest, how many hunters should it allow in the forest to maximize the total yield in the community? What is the average yield from the forest and what are total profits? Is this a Pareto improvement over the allocation in part (1)?
   The government want to maximize:

$$\max_N 0.05(150 - N) + N \cdot (\frac{1}{2}N^{-\frac{1}{2}})$$

$$\begin{aligned} [N] : -0.05 + \frac{1}{4}N^{-\frac{1}{2}} &= 0 \\ N &= 25 \end{aligned}$$

The government should allow 25 hunters in the forest in order to maximize the total yield. The average yield from the forest is now:

$$\frac{1}{2}N^{-\frac{1}{2}} = \frac{1}{2}(25)^{-\frac{1}{2}} = 0.1$$

which is higher than it was under no government intervention. Profits are now:

$$5 * (0.05 * (150 - 25) + \frac{1}{2} * 25^{\frac{1}{2}}) = 75$$

whereas profits in the first part of the question were:

$$5 * (0.05 * 150) = 37.5$$

We see that this is indeed a Pareto improvement over the allocation in part (1). No hunter is worse off, i.e.

all of the hunters are obtaining at least as great a yield as they were previously, but the hunters in the forest are now obtaining larger yields and earner higher profits.

4. **(5 points)** The government decides to sell permits for hunting in the forest. It chooses a price p and sells as many permits as hunters wish to buy at this price. What price p should the government charge per hunting permit to achieve the optimal allocation determined in part (3)?
We want to set the price for permits p such that exactly 25 hunters want to hunt in the forest. The indifference condition is profits from hunting in the forest equal profits from hunting on the plains.

$$\begin{aligned} 5 * (\frac{1}{2} * 25^{-\frac{1}{2}}) - p &= 5 * 0.05 \\ p &= 0.25 \end{aligned}$$

A permit to hunt in the forest which costs 0.25 will equate the profits associated with forest and plains hunting.

Some of you may have interpreted the problem as requiring hunters to obtain a permit per unit hunted. Under this interpretation, the indifference condition is the following:

$$\begin{aligned} (5 - p) * (\frac{1}{2} * 25^{-\frac{1}{2}}) &= 5 * 0.05 \\ p &= 2.5 \end{aligned}$$

5. **(5 points)** Assume the revenues from the sale of permits in part (4) are given back in equal amount to the 150 hunters as a lump sum. How does the welfare of the hunters under the permit scheme in part (4) compare to their welfare with no government intervention? Explain.
*Everyone is better off compared to the equilibrium with no government intervention. Note that this is not automatic (i.e. just because we internalized the externality, does not mean that everyone is better off). Total welfare is higher because we are at an efficient outcome where the externality has been internalized. Without the redistribution of the revenues from the sale, everyone is the same as with no government intervention (think about the indifference condition above). The total revenues from the sale of permits are 0.25*25 = 6.25 and are distributed equally across all hunters.*

6. **(5 points)** Wildlife ecologists observe that following the reduction in the number of forest hunters, some animals have been migrating from the plains to the forests. This increases the productivity of hunting in the forest but reduces it in the plains. Taking into account this migratory response, should the government be permitting a smaller or larger number of hunters to hunt in the forest than what you calculated in part (3)?
In general, if an activity generates a negative externality and the market doesn't correct it (e.g., through Coasean mechanisms), the equilibrium will have an inefficiently high level of the negative externality-generating activity (and vice versa for a positive externality). In parts (1) through (5) above, each hunter caused negative externalities for other hunters and, accounting for these social costs, there was too much hunting in equilibrium. Hence, you calculated that reducing the number of hunters would improve social efficiency. In part (6), we learn that not hunting also creates negative externalities for plains hunters. Accounting for this negative externality, it's likely that the efficient level of forest hunting is higher *than what we calculated above. Accordingly, efficiency demands a greater number of forest hunters than parts (1) through (5) suggested.*

The problem with Coase Theorem

1) The Coase theorem works if transactions are negligible: Suppose there is an airport and 2000 residents live near the airport. It will take a lot of energy and time to negotiate with all the residents – transaction costs will be huge
2) There is a role for government other than just defining property rights if there are externalities and transaction costs are substantial
3) Does not explain whom the property rights of an asset should be allocated
4) The holdout problem: Shared ownership of property rights gives each owner power over all the others (because joint owners have to all agree to the Coasian solution)
5) The assignment problem: In cases where externalities affect many agents (e.g. global warming), assigning property rights is difficult. Coasian solutions are likely to be more effective for small, localized externalities than for larger, more global externalities involving large number of people and firms
6) The Free Rider Problem: When an investment has a personal cost but a common benefit, individuals will underinvest (example: a single country is better off walking out of Kyoto protocol for carbon emission controls)

The Tragedy of the Commons

- A metaphor that refers to the ultimate destruction of a commons – such as a grazing pasture, an irrigation system, a fishing ground, or a forest – that occurs when users who are relatively numerous lack communication and overuse the commons

Elinor Ostrom-Nobel, 2009

Garrett Hardin

Esther Mwangi

Video: https://www.youtube.com/watch?v=Qr5Q3VvpI7w

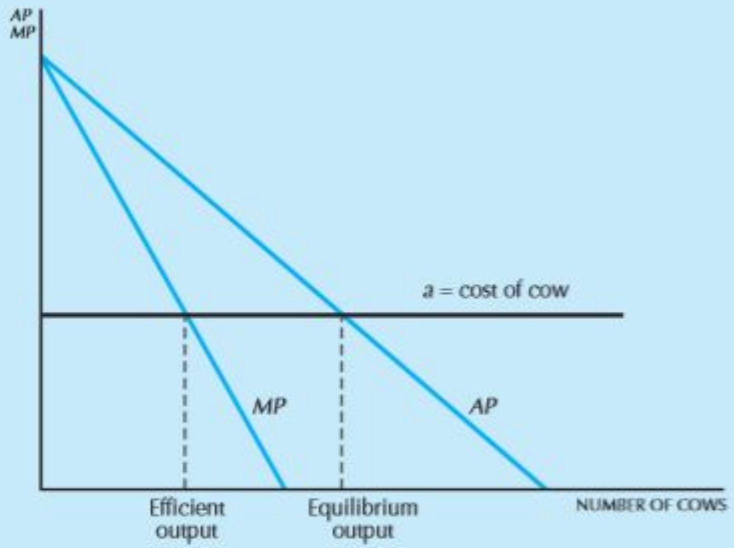
The Tragedy of the Commons

- We shall use an example of a grazing land
- Consider an agricultural village in which the villagers graze their cows on a common field
- Suppose that it costs α dollars to buy a cow
- How much milk the cow produces will depend on how many other cows are grazed on the common land
- We will let $f(c)$ be the value of the milk produced if there are c cows grazed on the common. Thus the value of the milk per cow is just the average product, $f(c)/c$

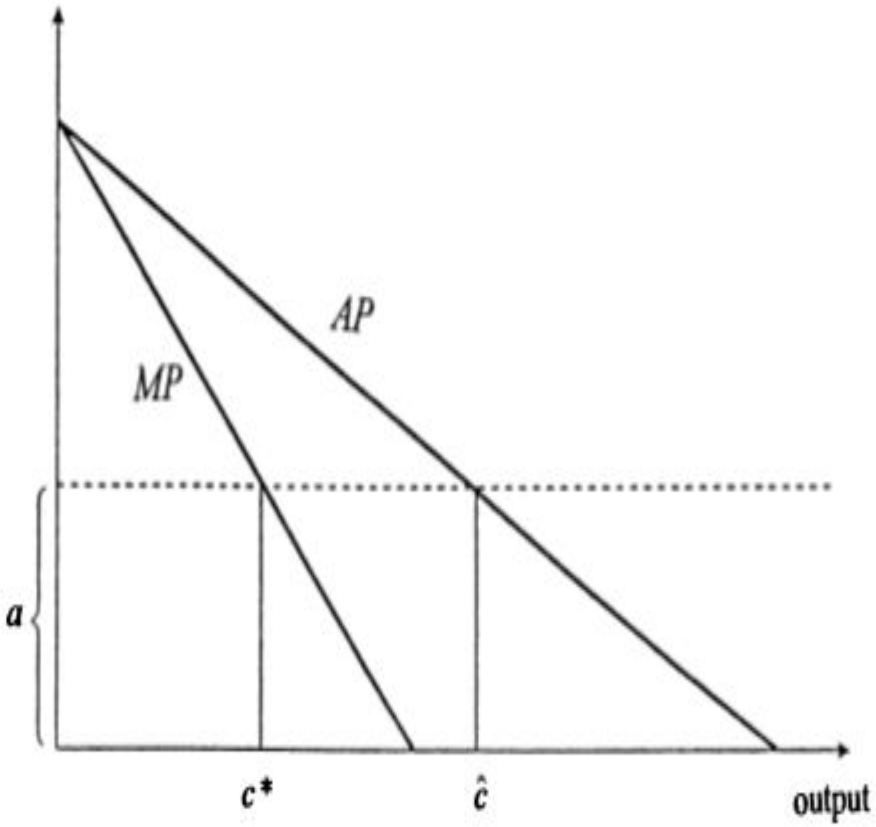
- Suppose that the field is privately owned, the number of cows grazed will be:
- $\max_{c} f(c) - \alpha c$ which results into: $MP(c^{*}) = \alpha$
- Hence, maximal production will occur when the marginal product of a cow equals its cost, α
- If the marginal product of a cow were greater than α, it would pay to put another cow on the commons; and if it were less than α, it would pay to take one off
- If the common grazing ground were owned by someone who could restrict access to it, this is indeed the solution that would result. For in this case, the owner of the grazing grounds would purchase just the right amount of cows to maximize his profits

- Suppose the field is communally owned
- Here each villager has a choice of grazing a cow or not grazing one, and it will be profitable to graze a cow as long as the output generated by the cow is greater than the cost of a cow
- Suppose that there are **c** cows currently being grazed, so that the current output per cow is $f(c)/c$
- When a villager contemplates adding a cow, the total output will be $f(c+1)$, and the total number of cows will be $c+1$. Thus the revenue that the cow generates for the villager will be $f(c+1)/(c+1)$. He must compare this revenue to the cost of the cow, α
- If $f(c+1)/(c+1)>\alpha$, it is profitable to add the cow since the value of the output exceeds the cost

- Hence the villagers will choose to graze cows until the average product of a cow is driven to α. It follows that the total number of cows grazed will be $\hat{c}$, where $\frac{f(\hat{c})}{\hat{c}}=\alpha$
- Another way to derive this result is to appeal to free entry. If it is profitable to graze a cow on the common field, villagers will purchase cows
- They will stop adding cows to the common only when the profits have been driven to zero
- When an individual decides whether or not to purchase a cow, he looks at the extra value he will get f(c)/c and compares this to the cost of the cow, a. This is fine for him, but what has been left out of this calculation is the fact that his extra cow will reduce the output of milk from all the other cows
- Since he is ignoring this social cost of his purchase, too many cows will be grazed on the common ground



The tragedy of the commons. If the grazing area is privately owned, the number of cows will be chosen so that the marginal product of a cow equals its cost. But if grazing area is common property, cows will be grazed until the profits are driven to zero; thus the area will be overgrazed.



Since the average product is falling, it must be that the marginal product curve always lies below the average product curve. Thus the number of cows where the marginal product equals a must be less than where the average product equals α. The field will be overgrazed in the absence of a mechanism to restrict use

Solutions to the tragedy of commons

- Coercive state involvement (by Hardin)
- Privatization provision (by Hardin) - individual use of the commons is more efficient and effective as self-interest drives people to better govern their assets
- Development of self-governing institutional arrangements to regulate the commons (by Ostrom)

[The tragedy of the commons.] On the island of Pago Pago there are two lakes and 20 anglers. Each angler can fish on either lake and keep the average catch on his particular lake. On lake X, the total number of fish caught is given by

$$F^x = 10l_x - \frac{1}{2}l_x^2$$

where l_x is the number of people fishing on the lake. For lake y the relationship is

$$F^y = 5l_y$$

(a) Under this organization of society, what will be the total number of fish caught?

(b) The chief of Pago Pago, having once read an economics book, believes it is posible to raise the total number of fish caught by restricting the number of people allowed to fish on lake X. What number should be allowed to fish on lake x in order to maximize the total catch of fish? What is the number of fish caught in this situation?

(c) Being opposed to coercion, the chief decides to require a fishing license for lake x. If the licensing procedure is to bring about the optimal allocation of labor, what should the cost of a license be (in terms of fish)?

(d) Explain how this example sheds light on the connection between property rights and externalities.

Solution:

(a) $F^x = 10l_x - 0.5l_x^2$ and $F^y = 5l_y$
First, show how total catch depends on the allocation of labor.

$$
\begin{gathered}
l_x + l_y = 20 \text{ thus } l_y = 20 - l_x \\
F^T = F^x + F^y \\
F^T = (10l_x - 0.5l_x^2) + (5l_y) = (10l_x - 0.5l_x^2) + (5\,(20 - l_x)) \\
F^T = 5l_x - 0.5l_x^2 + 100
\end{gathered}
$$

Equating the average catch on each lake gives

$$
\begin{gathered}
\frac{F^x}{l_x} = \frac{F^y}{l_y} \\
10 - 0.5l_x = 5
\end{gathered}
$$

then $l_x = 10$ and $l_y = 10$
and

$$
\begin{gathered}
F^T = 5(10) - 0.5(10)^2 + 100 \\
F^T = 100
\end{gathered}
$$

(b) The problem is to $max\, F^T = 5l_x - 0.5l_x^2 + 100$
thus the FOC wrt l_x is $\frac{dF^T}{dl_x} = 5 - l_x = 0$ then $l_x = 5$, $l_y = 15$ and then $F^T = 112.5$

(c) $F^x_{case\,1} = 10(10) - 0.5(10)^2 = 50$ average catch is $\overline{F^x_{case\,1}} = 50/10 = 5$
$F^x_{case\,2} = 10(5) - 0.5(5)^2 = 37.5$ average catch is $\overline{F^x_{case\,2}} = 37.5/5 = 7.5$
thus the license fee on lake X should be equal to 2.5.

(d) The arrival of a new fisher on lake X imposes an externality on the fishers already there in terms of a reduced average catch. Lake X is treated as a common property here. If the lake were private property, its owner would choose l_x to maximize the total catch less the opportunity cost of each fisher (the 5 fish he can catch on lake Y). So the problem is to maximize $F^x - 5l_x$ which yields $l_x = 5$ as in the optimal allocation case.

References

- Furubotn, E. G., & Richter, R. (2010). *Institutions and economic theory: The contribution of the new institutional economics*. University of Michigan Press.
- Varian, H. R. (2014). *Intermediate Microeconomics: A Modern Approach: Ninth International Student Edition*. WW Norton & Company.
- Mwangi, E., & Ostrom, E. (2009). A century of institutions and ecology in East Africa's rangelands: Linking institutional robustness with the ecological resilience of Kenya's Maasailand. In *Institutions and sustainability* (pp. 195-222). Springer, Dordrecht.
- Sarker, A., & Blomquist, W. (2019). Addressing misperceptions of Governing the Commons. *Journal of Institutional Economics*, *15*(2), 281-301.


THANK YOU