

External effects, externalities, and pollution

chapter 17 stuff:

erm: draft February 8, 2012

Externalities are a type of market failure - market failures are things inherent to the market that cause the market equilibrium allocation to be inefficient.

1 Let's start by defining external effects (what KW call side effects).

An external effect occurs when the actions of one economic agent directly affect, not indirectly through market prices, another economic agent.

Examples of external effects:

- I put plaster statues of Snow White and the Seven Dwarfs in my front yard, because it increases my utility, and this decreases or increases the utility of my neighbors—some like the Dwarfs, some don't
- I smoke a cigarette and you are subjected to second-hand smoke
- I smoke weed and you are positively affected by the second-hand smoke
- I take a bath because I can no longer stand the way I smell, which improves your life.
- I enjoy ax murdering people , so ax a few. The victims are worse off.
- The factory producing widgets emits a lot of pollution, making a lot of people in the neighborhood sick.
- I drive slowly to Vail on I-70 on a Saturday winter morning, slowing down everyone behind me.
- You stand up at a concert so you can see better, making it harder for the guy behind you to see.
- I watch porn in my windowless basement. The neighbor knows I am doing it, and is made worse off (better off)
- My driving increases CO2 emissions, which makes future generations worse off.
- You kiss mabel on the lips? And she kisses you back.

All of these are examples of actions that cause external effects: some positive and some negative.

Like everything else there is an efficient amount of each side effect. The question is whether the unregulated market will produce the efficient amount of the external effect

The answer is **often**, NO.

Consider cigarette smoking:

cigarette, match, etc. WE DID THIS ALREADY, but think it through.

Like the consumption of everything, we, as a society, want cigarettes consumed up to the point where the marginal benefits to society from the last cigarette consumed just equals the marginal cost to society from the last cigarette consumed.

If it very unlikely that zero is the efficient number of cigarettes smoked.

Things are interesting because the cigarette smoker does not incur all of the benefits and costs of her smoking.

Remember that the smoker is typically a member of society.

2 Before we consider cigarettes, consider a commodity with the following properties:

- consumption of the product affects only the consumer, no one else
- and, production of the product by a firm has no direct effect on other firms or consumers.

What would be an example of such a product? What should we call should a product with these properties? A "purely private" good?

Maybe there are not many good examples. How about listening to your IPOD? Wearing women's dresses in your private and personal closet? Reading a book, by yourself?

We can all think of reasons why there might be external affects associated with the consumption of these products.

So, they are not perfect examples.

Can you think of a better example, a good who production and consumption



has no external effects?

3 My example will be George's tattoos



Best tattoo gets \$x contest

3.1 George never takes off his clothes in the presence of other people, so no one else ever sees his tattoos. The tattoos do not affect George's interactions with other people: George never talks about his tattoos, they never affect what he says or how he behaves in social situations.

Also assume George does his own tattoos, and the production process has no effect on others (we are assuming tattooing yourself creates no pollution).

Let t be the number of tattoos on George

So, given my assumptions. the private benefits to George of adding an additional tattoo (marginal private benefit, $MB_G(t)$) equals the marginal social benefit ($MB_s(t)$) of an additional tattoo. It depends on t . Assume George is a member of society and he is the only member who will see the tattoo.¹ Let's measure benefits and costs in dollars.

And, given my assumption about the production of George's tattoos, the marginal private cost of producing another tattoo, $MC_G(t)$, equals the marginal social cost of producing the tattoo, $MC_s(t)$.

¹Does it matter whether non-members see them? This thought could produce a question for the final.

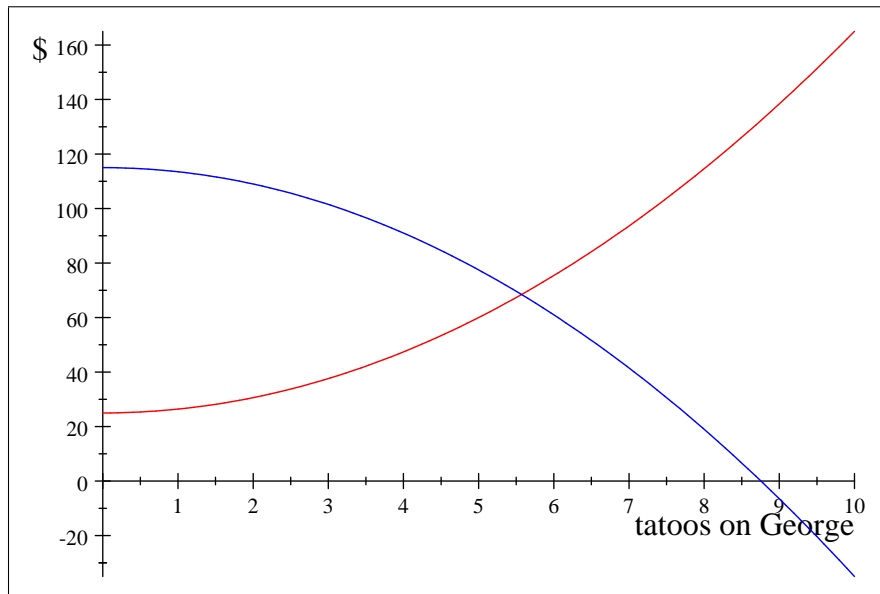
Assume the marginal benefits George gets from his tattoos start positive, are downward sloping, and eventually go negative.

Assume marginal costs are positive and upward sloping: George starts with the most accessible spot, but it is damn hard to tattoo yourself on the middle of your back.

3.1.1 Draw a graph: number of tattoos on George on the horizontal axis, and \$ on vertical axis.

label the curves $MB_G(t)$ and $MC_G(t)$

To draw the graphs, I will assume $MC_G(t) = 25 + 1.4t^2$ and $MB_G(t) = 115 - 1.5x^2$



George: marginal cost (red), marginal benefit to (blue)

What would explain the the increasing marginal cost and the decreasing marginal benefit?

What is the efficient number of tattoos **from George's perspective** (his utility-maximizing number)?

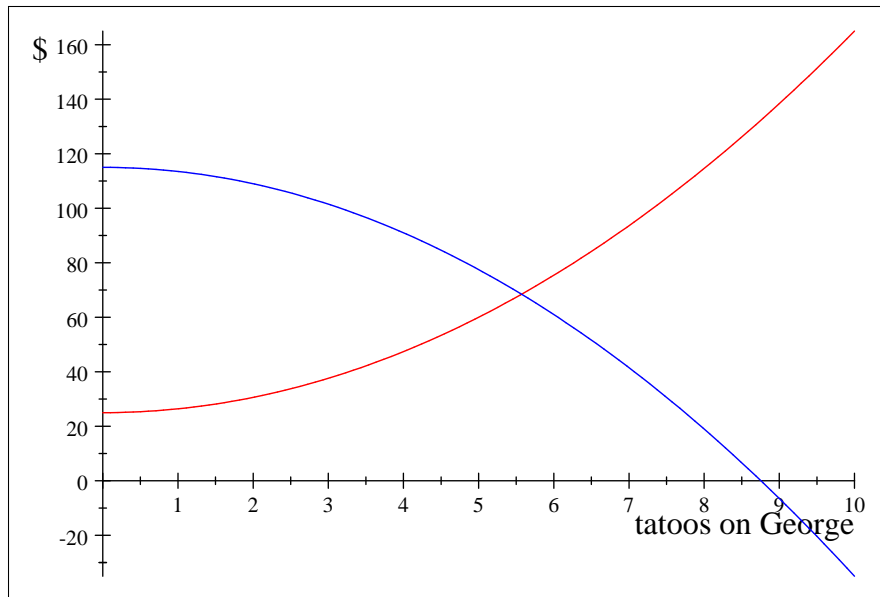
At equilibrium for George $25 + 1.4x^2 = 115 - 1.5x^2$, Solution 5.57 tatoos. George maximizes his utility by having 5.57 tatoos.

What is the efficient number of tattoos from society's perspective?

In this case $MB_G = MB_s$ because only one member of society gets benefits from George's tattoos, George

In this case $MC_G = MC_s$ because only one member of society incurs any costs in the production of George's tattoos, George

There are not external effects (side effects)



George and Society: marginal cost, marginal benefit

So, in the case, selfish George maximizing his own utility achieves the efficient number of tattoos, on George, from society's perspective. The market is working - the wonders of the invisible hand in the production of tattoos.²

²Did Adam Smith have tatoos?

3.2 Now George decides the world will be a better place if he wears as few clothes as possible - George has been reborn and forsaken clothes: everyone else now sees his tattoos, and everyone is not pleased.

Now, assume $MB_s(t) < MB_G(t)$. Specifically assume $MB_{others}(t) = -10t < 0$: George's tattoos make other people worse off - decreases their utility. For example, his mother hates them, and she hates each additional one more than the previous one.

Assume that George gets the same pleasure/utility from his tatoos whether he does or not wear cloths: he is not going naked so others can see his tatoos. He goes naked simply because it make him feel free.

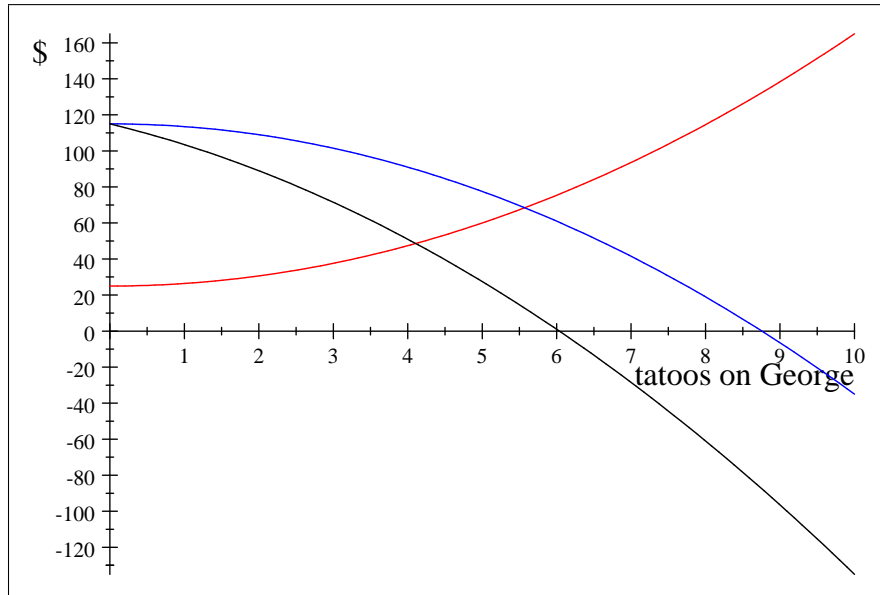
To keep things simple, let's also assume that we don't care about his nakedness per sec, only that we can see the tatoos.

Note that $MB_s(t) = MB_G(t) + MB_{other}(t)$, remember George is a member of society, like everyone else.

George's tattoo consumption produces a negatvie external effect on others.

In the graph, I am assuming $MB_{others} = -10t$, as I assumed above. The

blue line is $MB_G(t)$ and the black line is $MB_s(t)$. How would you describe the vertical distance between the blue and black lines?



George and Society: marginal cost, marginal benefit

In this case, the efficient number of tattoos **from George's perspective** is still 5.57 tattoos (the number he will get if society does not try to influence him). But the efficient number showing from society's perspective is where $MC_s(t) = MB_s(t)$, at that t where $25 + 1.4t^2 = 115 - 1.5t^2 - 10t$. Solution is 4.11 tattoos on George.

Utility maximizing behavior on the part of George is good for George, but produces too many tattoos showing on George from Society's perspective : $5.57 - 4.11 = 1.46$ too many

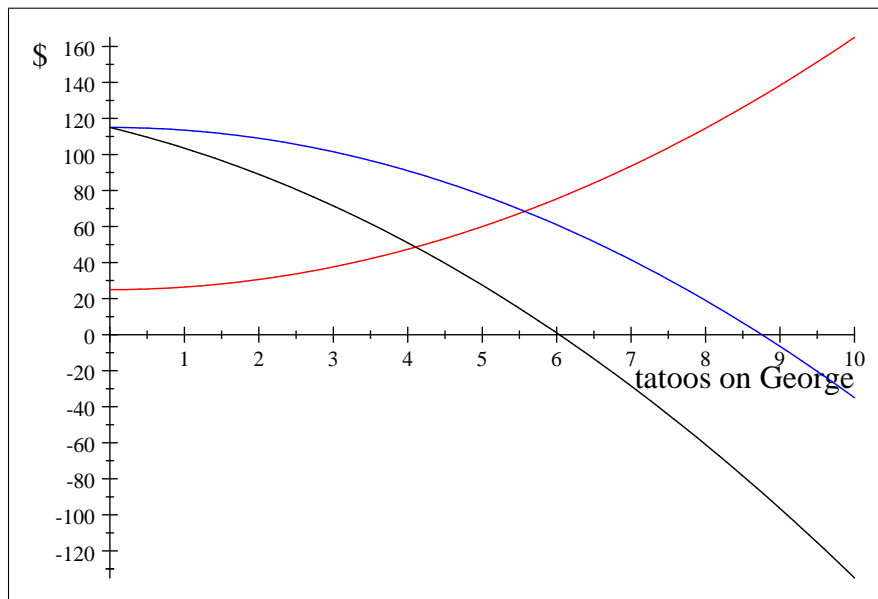
George when he decides how many tattoos to have does not appropriately take into account the the negative external effect caused by him exposing his tatoos in public, so there is a negative-externality-type market failure. (I will formally define externalities in a page or two.)

Make sure you understand and can explain why the efficient number of tatoos is not zero from society's perspective.

3.2.1 A way to recast the above: a negative benefit to others can view interpreted as a negative benefit (as I interpreted it above) or as an additional cost imposed on others.

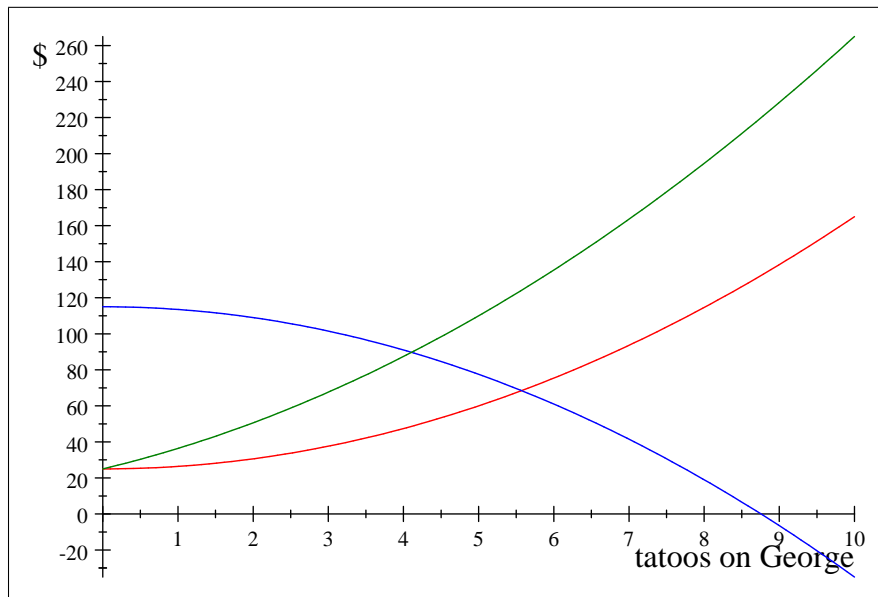
Look again at the above graph where $MC_G(t) = MC_S(t) = 25 + 1.4t^2$,
 $MB_G(t) = 115 - 1.5t^2$
and $MB_{other} = -10t$,
so $MB_S(t) = 115 - 1.5t^2 - 10t$

Just what we had above



mc Grg. and Soc. (red), mb George (blue), mb Society (black)

This is equivalent to assuming the the external effect is reflected by marginal private cost not equaling marignal social cost, with marginal private and social benefits equal: $MB_G(t) = MB_s(t) = 115 - 1.5t^2$,
 $MC_G(t) = 25 + 1.4t^2$
and $MC_S(t) = 25 + 1.4t^2 + 10t$, all graphed next



mc Grg (red), mc Society (grn) and mb Grg and Society (blu)

Notice in this representation of the problem, marginal social cost of George's tattoos are imposing a cost on society. If George does not experience this cost - have to take account of it - he will have too many tattoos.

Summarizing, one can model a negative external effect as either putting a wedge between private and social benefits or putting a wedge between private and social costs.

We can think of George's tattoos as *visual pollution*: they are having a negative effect on others.

4 The efficiency problem is that George does not take this negative effect into account when he decides how many tattoos to show in public.

George does not get more pleasure from his tattoos by revealing them, nor does it bother him to reveal them, but he does get pleasure from them all of the time, at home and in public.

The inefficiency is caused by the combination of two things:

- George's actions (showing them) directly affect others (an external effect is occurring (a side effect))
- When George decides how many tattoos to show in public he is not compelled to take account of how he is affecting others

We have a negative externality market failure (too many tattoos are being shown from society's perspective).

Externality: an externality occurs when one economic agent's actions directly affect another economic agent (not through market prices) and the producer of the external effect does not have the correct incentive (not compelled) to take the influence of their actions into account.

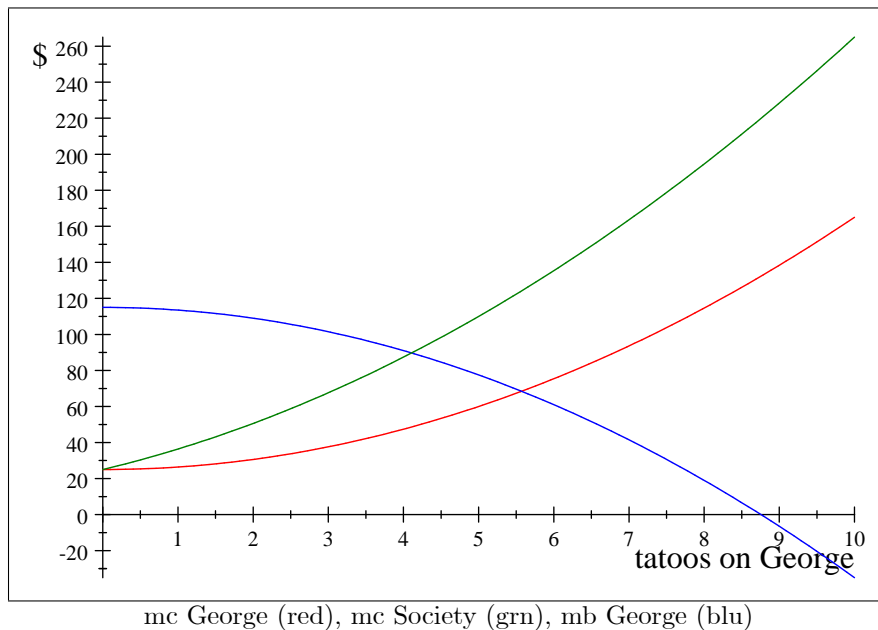
Said another way: An externality occurs when an external effect is being produced at an inefficient level.

4.1 How to eliminate the inefficiency?

Think about the assumptions I made in setting up the problem. George's tattoos only cause a negative effect when they are seen in public, so the inefficiency is not caused by the number of tattoos that George has on his body, but rather the number showing in public. This is an important point; we want to regulate the number showing, not the number he has.

We simply want to force, compel, or entice George to have 4.11 tattoos showing, rather than 5.57 tattoos showing

Remember it is efficient for 4.11 to show



4.1.1 There are numerous ways to do this:

- Pass a law saying that George must have 4.11 tattoos showing - sounds un-American (the government is restricting freedom)
- Pass a law saying that George cannot have more than 4.11 tattoos showing (and George with then "chooses" 4.11)
- Tax George for every tattoo showing, and set the tax so George "voluntarily chooses" to have 4.11 tattoos showing. This tax rate is the tax rate that eliminates the wedge between marginal private costs, $MC_G(t)$, and marginal social costs, $MC_s(t)$, of his exposed tattoos. It is a visual-pollution tax. Put simply, if George is paying the complete social costs of his actions, he will do the efficient thing from society's perspective.

Note that George can respond to the tax or regulation by either not getting an additional tattoo, or getting it and then covering part of his body when he goes out in public. Regulating/taxing exposed tattoos is likely more efficient than regulating/taxing tattoos because the former gives George an additional way to achieve the goal: get the tattoo, but not show it in public.³

Less practical ways to achieve 4.11 tattoos showing

- Pass a law clarifying property rights, a law that says that George cannot have tattoos showing unless everyone else is OK with it. In this case, society could potentially end up with 4.11 exposed tattoos on George because George has an incentive to bribe people so can go naked, or at least partially naked.
- Pass a law clarifying property rights, a law that says that George can have as many tattoos as he wants. In this case, society could potentially end up with 4.11 tattoos on George because other people have an incentive to bribe George to not get show his tattoos.

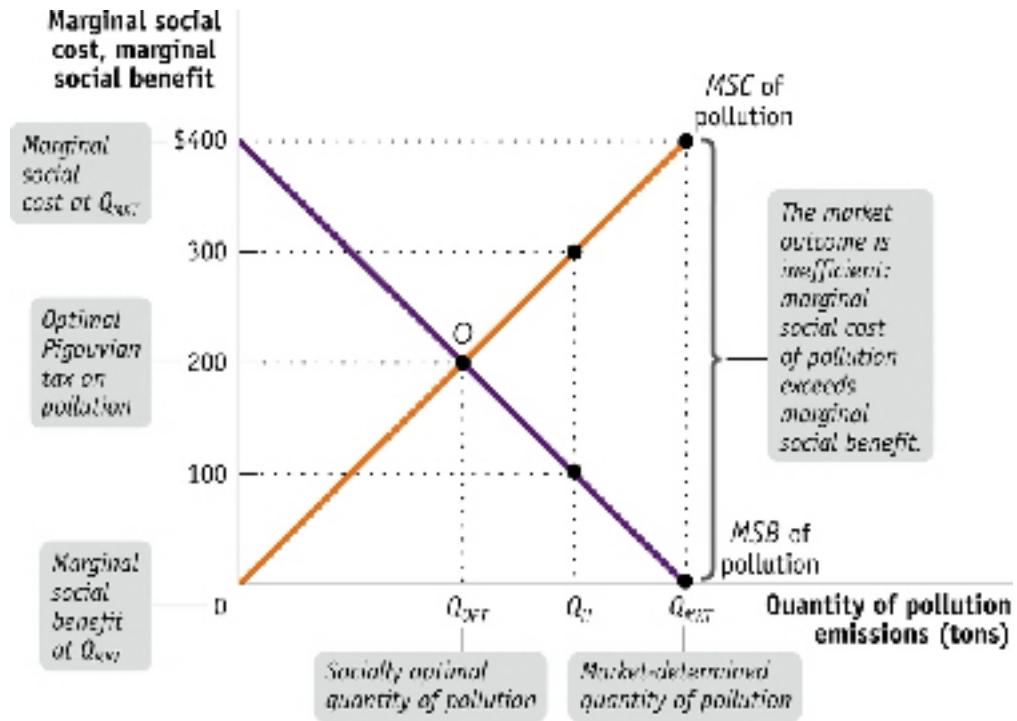
These last two ways of eliminating the inefficiency are *Coasian* solutions (mentioned in chapter 17): clearly define the property rights and let the players work out the trades that would get society to efficiency. Such a process probably won't work in this case because George's tattoos are affecting a lot of people.

That is, these solutions are unlikely to work if there are a lot of players involved.⁴

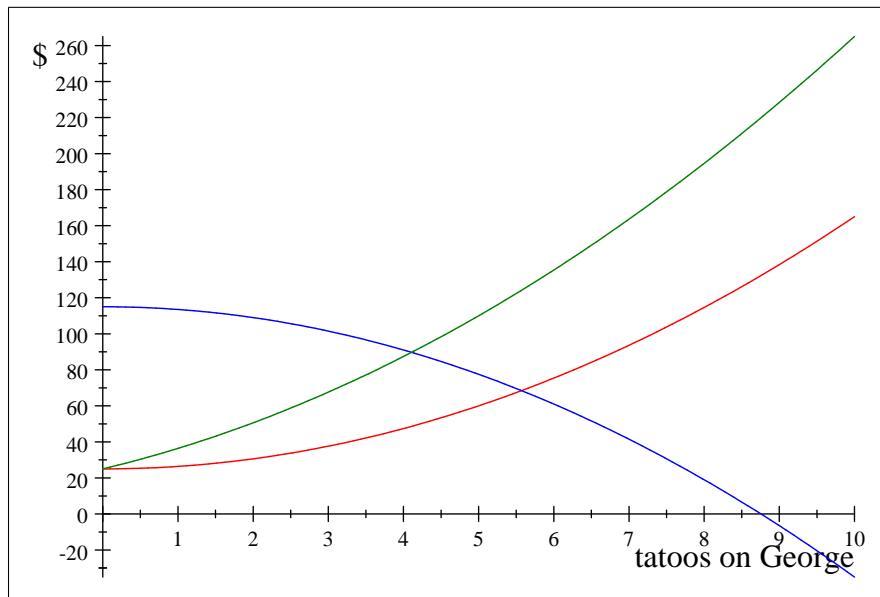
³If George prefers to get more than 4.11 tattoos and then wear some cloth in public to only having 4.11 tattoos on his body, the regulation/tax on exposed tattoos is more efficient than a direct regulation/tax on tattoos.

⁴For example, if George has the property rights the rest of us have to bribe him to show less. The problem is that I would prefer you pay the bribe so that I get the benefit at zero cost to me, and you prefer that I pay the bribe and you get the benefit at zero cost.

5 Let's related the above to some of the stuff in Chapter 17

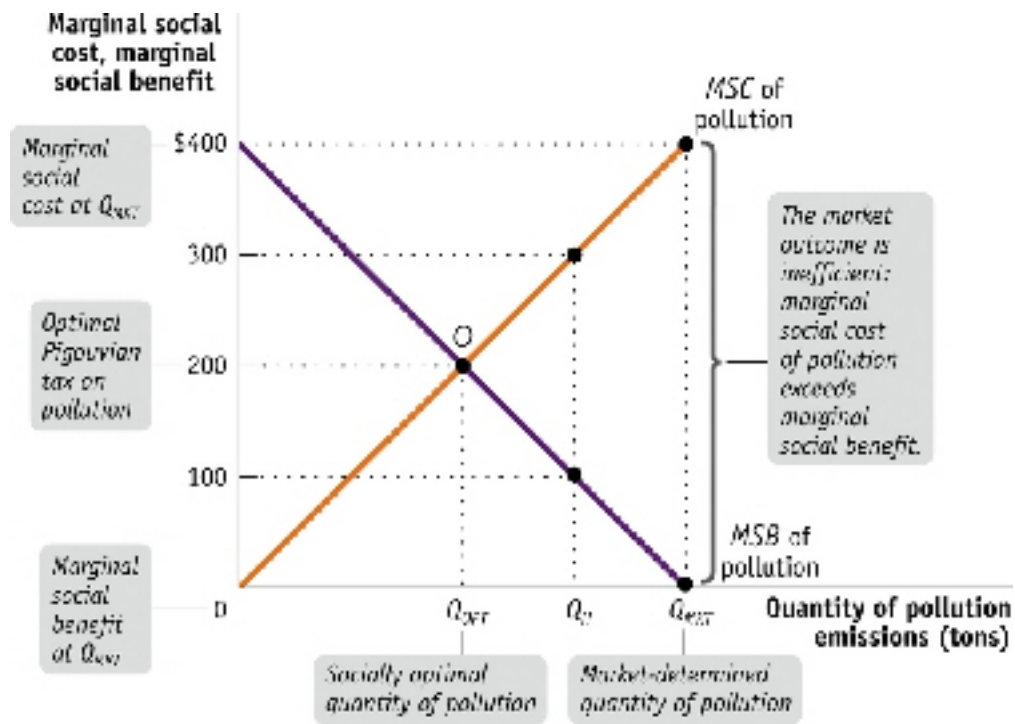


Compare this graph to mine (we both have \$ on the vertical axis).



George and Society: marginal cost, marginal benefit

5.1 I find the KW graph much more difficult to decipher. First let's try to explain it. When we understand it, we can relate it to my graph



The commodity being graphed by KW is pollution, so they are graphing only the external effect (the side effect).⁵

The downward-sloping purple line in the KW graph is a marginal cost curve for reducing pollution (pollution abatement) read right to left. What it says is that on the margin it cost little to reduce pollution by one unit starting from its current high level, but that the cost of abating additional units increases as one abates more and more units (the curve increases as one moves from right to left).

KW call it a "marginal social benefit curve" because reducing pollution uses resources that could be used to produce other things; so, in that sense there

⁵ Implicitly there is some good that is being produced and the pollution/emissions are a side effect of producing that good. In the tattoo example, George is producing tattoos on his body, and the external effect is others seeing them.

is a "benefit" to polluting—resources that are could have been used to clean up pollution are available for other uses. (A benefit as in "we have bigger TV screens because we do not clean up our pollution.")

Notice that it is expensive to completely abate all of one's pollution. (Typically, it is too expensive to eliminate all pollution.)

The marginal social benefits of polluting curve shows that if no one regulated how much this firm or industry pollutes, the equilibrium level of pollution (the efficient level for the firm/industry) is Q_{mkt} :this is how much pollution the firm produces if no one penalizes it for polluting.

The upward-sloping red line identifies the marginal damage to society from different levels of pollution. It indicates that if there is no pollution, there are no damages to society from pollution, but that as pollution increases the marginal damage (cost) increases.

What is the efficient amount of pollution from the industry's perspective? Q_{mkt} . But from society's perspective it is Q_{opt} the unregulated market is failing - there is more than the efficient amount of pollution.

There is an externality-type market failure.

5.2 How might the government eliminate the inefficiency in the KW graphical example

- Impose a pollution tax of \$200 per unit of pollution (see the graph). A tax of this amount will induce the firm/industry to produce Q_{opt} pollution. The firm has a profit incentive to reduce pollution down from Q_{mkt} as long as the cost of abating the marginal unit is less than \$200 (as long as the purple line is below \$200.)
- If all of the pollution is coming from one firm, pass a law saying the firm cannot pollute more than Q_{opt}
- Issue Q_{opt} pollution permits and let firms buy and sell them

6 When it comes to environmental resources, many of them are not efficiently used from society's perspective.

There are lots of externality-type market failures

- Global warming. When you decide how much CO_2 to emit, you do not take into account the cost you are imposing on future generations because of your emissions, because you are not required to.⁶ None of us are required to. We drive, for example, the efficient amount from our own perspective, but we each emit too much CO_2 from society's perspective.
- Excess pollution and congestion from driving. Correct by turning I-70 into a toll road?
- We over use our public parks and natural areas (but not Disney Land) because we are not required to pay the cost we impose on others, others today and others in the future when we visit the park.
- We are overfishing many of the world's fish stocks because of the gap between the private costs and social costs of harvesting fish.
- Firms emit too much junk into our air and water because the the marginal private cost of polluting is less than the social cost.
- We pump water out of our aquifers too quickly from society's perspective because those who pump the water do not consider the opportunity cost of their pumping on other potential users of the water.

To be clear if the production of these things are efficiently regulated, external effects will remain but there will be no market failure (no inefficiency in their production).

⁶Note that I am assuming that CO_2 emissions contribute to global warming, a position held by the vast majority of environmental scientists, but not by Rick Santorum (Republican aspirant to the Presidency).

There is, potentially, a big role for the government(s) to play in the allocation of our scarce natural and environmental resources, to correct externality-type market failures.

Why do many object to a bigger role for the government? Possible reasonable reasons:

- They do not believe that there are significant externality-type market failures
- They believe Coasian type bargaining, with no government action, will eliminate externalities.
- Even if market failures exist they believe that government intervention will just screw things up more from an efficiency perspective
- They do not accept efficiency as the goal. For example, some people believe freedom to do as one pleases: liberty, is more important than increased efficiency.

Note that the problem of not achieving efficiency is one of property-rights not being well specified. And, as we learned earlier, if a resource is scarce but does not have well-defined property rights, the market will not efficiently allocate it.

A issue with the liberty goal is that you being allowed to do whatever you want often affects me negatively. That is giving you more freedom often reduces my freedom. E.g. if you are free to run around shooting off guns, my freedom to walk safely in the woods is reduced.