[SQUEAKING]

[RUSTLING]

[CLICKING]

JONATHAN GRUBER: Externalities, so, so far in the class, we once again remember the big picture. We started with the first fundamental theorem overall for economics, which is that the competitive market will maximize total social welfare. Then we said that will not be true under conditions of market failure. Remember, market failure doesn't mean market collapse. It means when there are barriers to the market achieving this first best outcome, OK?

One barrier is imperfect competition. One barrier was imperfect information. A third barrier to welfare maximization or a third source of market failure is externalities, OK? That's the third source of market failure, and we're going to talk about that today.

What is an externality? Let me be very clear about the definition. An externality occurs whenever one party's actions makes another party better or worse off, OK? Let's do it-- let's make it a person, whether my actions make you better or worse off, but I don't bear the consequences of that. So, when my actions make you better or worse off, but I don't bear the consequences, then there's an externality.

So let's talk about that in the context. Let's start with the classic example of externalities, which is a negative production externality, a negative production externality, OK?

The classic example is you've got a river. On that river is a steel plant. That steel plant produces steel, OK? But, as a byproduct of that production, it dumps sludge into the river, OK? You guys remember *The Lorax?* So it's basically *The Lorax,* OK?

So, basically, the steel plant dumps sludge into the river, OK? That sludge floats down the river and kills the fish. Those killed fish mean that fishermen cannot make as much money fishing on the river, OK? So, basically, there's sludge coming out of

the factory, and that sludge we're going to make the assumption is directly proportional to the production of steel.

So we're going to say, for every unit of steel produced, there's one unit of sludge that emits on the factory just to make this model easy. So, every unit of steel, there's one unit of sludge. That sludge flows down the river and kills the fish. Unfortunately, there are fishermen down this river who are trying to catch fish, and that hurts their livelihood, OK?

So this is a classic example of living by an externality, because the steel plant's behavior is imposing a cost on the fishermen. Their sludge is imposing a cost on the fishermen, but the steel plant doesn't bear any consequence of that. They just dump the sludge and forget about it, OK?

So that's what we mean by negative. It's a negative externality because my actions are hurting you. The steel plant's actions are hurting the fishermen. It's a production externality because it comes out of the production process, in this case, for steel.

So that's what we mean by negative production externality. It means that, when one party's production adversely affects another party, but the party doing the production doesn't bear any consequences of that, then that's a negative production externality. So what effect does that have? Let's go to figure 22-1 and talk graphically about how we think about production externalities, OK?

This is the market for steel. In figure 22-1 is the market for steel, the quantity of steel on the x-axis, the price of steel on the y-axis, OK? The market is initially in equilibrium at point A. That is where demand, which is the downward-sloping blue line, equals supply, which is upward-sloping blue line.

Now, as we said, in a perfectly competitive market, demand represents the marginal willingness to pay for the good, which is equal to the marginal benefit that consumers get from consuming the good, OK? The marginal benefit of consuming the good is the marginal willingness to pay. And that's what's represented by the demand curve, OK? We're not going to touch that here. We're going to leave that alone, OK?

The supply curve is the firm's marginal willingness to supply, which is their marginal

cost, OK? So, in the perfectly competitive market where marginal benefit equals marginal cost, we get equilibrium. And that yields the welfare-maximizing outcome. The market succeeds. It does not fail, OK?

The difference now is we're now going to drive a wedge between privately perceived benefits and social benefits. So, for the consumption of steel with the demand curve, we're going to see the benefit to individuals is the benefit to society. They're one and the same. That's what we've assumed all course.

But, for the supply of steel, we're going to say wait a second. The benefit to society is different than the benefit to the steel producers. Or I'm sorry. The cost to society is different than the cost to the steel producers.

The cost to the steel producers, which is their private marginal cost, is the supply curve, but the social marginal cost adds the damage they're doing to the fishermen. That is society encompasses all the actors in society. It encompasses both the steel plant and the fishermen.

So the marginal cost to society is the cost of producing the steel plus the marginal damage being done to the fishermen. So social marginal cost equals private marginal cost plus marginal damage. Social marginal cost equals private marginal cost plus the marginal damage. And we see that as the red line.

What that means, from a welfare perspective, what we care about is social marginal benefits and costs, not private marginal benefits and costs. So what that means is the social optimum, the welfare-maximizing optimum, is actually at point C. Point C is the welfare-maximizing optimum where the social marginal cost equals the social marginal benefit, OK?

And, therefore, we overproduce. What's happening is the steel company, not considering the damage they're doing through production to the fisherman, produces too much. The steel company produces at the point where private marginal cost equals private marginal benefit, which, in our case, equals social marginal benefit, OK? That's the private market decision.

But, in fact, it should be producing at the point where social marginal cost equals private marginal benefit, private marginal benefit-- equals social marginal benefit,

OK? And the point where social marginal cost equals social marginal benefit is lower production. Why? Because lower production avoids-- reduces the damage being done to the fishermen down the river, OK?

So the optimum, from society's perspective, is point C. In other words, there is a market failure. The private market is not delivering the welfare-maximizing outcome. And we can see that creates a deadweight loss. The deadweight loss is the units that are traded that are socially inefficient.

Why are they socially inefficient? They're privately efficient. If you see Q2 and Q1, before we introduced externalities, we'd say, well, it's a shame if they don't get produced, right? If we ignore externalities, we'd say, Q2 and Q1, well, they have a benefit higher than their cost. So they should get produced. But, actually, in a world of externalities, their benefit is lower than their cost because their cost incorporates the damage done to the fish. So there's a deadweight loss.

Critically, remember, you've got to know how to draw these deadweight loss triangles. Remember, deadweight loss triangles always point to the optimum. The deadweight lost triangle is the area ABC, OK? It's drawn-- it's units that are sold where the social marginal cost exceeds the social marginal benefit. And that's that deadweight loss triangle.

So there's an inefficiency arising from the fact the private actors do not account for the social implications of their actions, OK? Questions about that? So we have here a classic example, perhaps the classic example in all of economics, of a market failure.

The classic example is a market failure happens when the social implications of your actions are different than the private implications since people maximize their own private well-being. That's what Adam Smith sort of taught us. The notion of the invisible hand is that the market acting in its own interests will deliver the best outcomes for society. We're saying, no, that's not true if the market's own interests has implications for other parties that are not accounted for, OK?

Now externalities don't have to just be on the production side. We can also have negative consumption externalities. That would be a case where my literally consuming a good makes you worse off. My consuming a good makes you worse off,

OK?

So let me start with a simple question. Let's start with a perfectly competitive market. If I consume a good, I raise demand for that good. That raises the price. Is that an externality?

In a perfectly competitive market, it's not. Why isn't that an externality? If I consume the-- if I want to consume the good, the price goes up. Everyone pays a higher price. Why is that not an externality? Yeah?

STUDENT: Because you also bear the cost.

JONATHAN GRUBER: Because you also bear the costs. An externality only occurs when you don't bear the costs of your actions. When you want a car, and, therefore, the price of cars goes up, you pay that higher price. Externalities only occur when you don't bear the consequences.

So, in general, consumption externalities don't happen through causing higher prices. Consumption externalities happen more directly when my consumption affects you. So the best example of this would be smoking, OK?

When I smoke, it affects you. It affects you in a number of ways. Most directly, if I smoke in this classroom, you get secondhand smoke, and you get ill as a result.

But that's not all. It affects you because, if I smoke, and I get sick, and my health care costs go up, then, well, I work at MIT. All my fellow MIT employees bear those costs because we all share health insurance. And, when I retire, all society bears those costs because those costs are paid for by the Medicare program, which is financed by taxation.

So my health care costs are an externality. Secondhand smoke is an externality. What are some other externalities from smoking? What are other externalities that can occur from smoking? Yeah?

STUDENT: Environmental damage from the production.

JONATHAN GRUBER: Well, that would be a production externality, OK? We're going to leave that alone for now. I'm just talking about from consuming cigarettes. From consuming cigarettes,

what else-- what other damage comes?

So I make you-- I may make you sick through secondhand smoke. I might raise health care costs. Well, I might raise health care costs, OK? What else is another externality? What else does smoking do?

Well, it turns out there are 100,000. This is a number which I triple check because I still can't believe it. 100,000 people every single year die in fires caused by smokers, not in the US, worldwide, which is a crazy number. But, if you think about how tightly packed slums are in developing countries, one person falling asleep with their cigarette burning can kill thousands of people, OK?

That is an externality because my action to smoke has killed you, OK? And I'm clearly not going to compensate you for that. So that's another externality, OK?

What about the fact that smokers are less productive at work. They have to take more smoke breaks. They might get sick more often. Is that an externality or not? The fact that smokers are less productive at work, is that an externality or not? And why or why not? Yeah?

STUDENT: Not necessarily because, if they're less productive, they're going to do less work and get paid less.

JONATHAN GRUBER: Exactly, it's not an externality if they're paid less. This is the key thing, which is it's only an externality if you don't bear the consequences. If smokers are less productive at work, and they get paid less as a result by exactly the same amount they're less productive, there's no externality.

But, if their wage doesn't fully adjust, and, therefore, their lower productivity affects everybody else in the firm or the firm's profits, that is an externality, OK? So this is the deep aspect of externalities. You have to think about whether people are compensating for it, OK? You have to think about that.

OK, most importantly, the fact I kill myself by smoking is not an externality, OK? Smokers die seven years earlier on average. Roughly speaking, every cigarette you smoke lowers your life by seven minutes. It's pretty linear, OK?

But you know what? If I sit by myself on a rock in the middle of nowhere and smoke

until I die, no problem because, in that case, the social implications are the private implications. I've made my privately optimal decision, and there's no effect on anybody else. So it's also socially optimal.

There's only an externality if we have one these mechanisms, like if I'm smoking, I'm in the woods, and I start a fire, and the fire company has to come. That's an externality. But, as long as I just sit by myself, and I don't bother anybody-- I just smoke until I die-- there's no externalities, OK? So externalities come through the effects on others.

So let's think about the externalities of smoking. Let's think about a negative consumption externality, OK? Here we have the market for cigarettes. On the x-axis, we have the number-- I'm sorry, figure 22-2. On the x-axis, we have the number of cigarettes, quantity of cigarettes consumed. On the y-axis, we have the price of cigarettes per pack.

We have an initial equilibrium at point A, which is where the private marginal benefit equals the private marginal cost. Here we're going to assume there's no externalities from producing tobacco. Let's assume there's no sludge produced, whatever. That's a separate issue, OK?

There may be production externalities too. We covered those. You already know how to think about those. But here let's assume there aren't any. Let's assume the social marginal cost equals the private marginal cost, no production externalities.

But there is a consumption externality. Every cigarette I smoke is bad for society. What that means is the social marginal benefit is below the private marginal benefit. The social marginal benefit is the private marginal benefit minus the marginal damage I'm doing. MD is the Marginal Damage, the marginal damage I'm doing.

That's estimated to be about-- absent secondhand smoke, the damage of smoking is about $0.50 a pack. The secondhand smoke part is really hard, and the estimates are anywhere from $0.01 to $2 per pack. So that's hard to know how big that is, OK?

But, certainly, we have this negative consumption externality, which is that, basically, every pack of cigarettes I smoke is worth at least $0.50 less to society

than it's worth to me because I have these external effects on society and perhaps a lot more than that. As a result, I should smoke-- I choose to smoke at point A, but the social optimum is point C.

So, once again, I've created a deadweight loss. Once again, I'm over consuming. There's overconsumption here. Just like there was overproduction of steel. There's overconsumption and a deadweight loss because there are units that are privately optimal to consume, but not socially optimal.

Now, externalities, this is kind of a fun topic because it is interesting. I talk-- so let's talk for a second about secondhand smoke and whether that's actually an externality. So almost all the damage of secondhand smoke is not done by smoking in a crowd. It's done to family members.

Almost all the damage of secondhand smoke is done to family members. Mostly, it's that you make your family members sick by smoking. Is that an externality? When or when is it not an-- under what conditions might it not be an externality? Yeah?

STUDENT: Well, I guess it wouldn't be an externality if like let's say you die. And then the consequences of them getting sick doesn't affect you at all. Or, well, I guess it--

JONATHAN GRUBER: No, no, then it-- no, then it would be. OK, so what-- under what conditions-- under what conditions would it not be an externality? When-- yeah?

STUDENT: If your-- like, if your family gets sick, and you are impacted by that.

JONATHAN GRUBER: Yeah, if I care about my family, in particular, if I maximize family utility, then it's not an externality. If I maximize not my own utility, but my family's utility, then I will essentially internalize, internalize, the externality. Just like a lower wage means that I bear the consequences for being a less productive worker, if I care about my whole family's happiness, and I make my kids sick by smoking, then my smoking decision will actually reflect the total consequences for my family.

I will smoke only if it's optimal for my family for me to do so. It doesn't mean I won't smoke. It just means I must-- I'll have to enjoy it enough that it's worth making my kids sick, OK?

It doesn't mean that's an incorrect decision because, after all, the odds are you

don't make your kids that sick, and, you know, you might like smoking a lot, OK? It's just that you will internalize the externality because you only smoke to the extent that it is optimal for the whole family. So it's not necessarily an externality, OK?

So we'd like, actually, to test whether it's an externality. There's actually a clever test of this, which is there's a test of whether people maximize family utility, which is, if people maximize family utility, what would be the implications of giving a father $1 versus giving a mother $1? If both the father and the mother are maximizing a family utility function, the same family utility function, then should it matter whether I give $1 to a father or $1 to a mother?

No, it shouldn't because that's $1 to the family. We're maximizing family utility subject to a family budget constraint. It shouldn't matter who gets the dollar.

So one test of family utility maximization is does it matter who gets the money. And it turns out it does a lot, OK? So there was a great test of this. In the UK, they used to have a tax system where, essentially, there was a credit they gave for every kid. And the way the credit worked is there would be a check sent home, OK?

Then they changed it. So, instead, they said, well, instead of sending a check home, we're just going to add it into pay, into wages. So, instead of getting a check sent home, we're just going to raise your wages. Well, it had no effect on family budgets. They literally just changed it.

The difference was, back in-- this was in the '70s. Men worked and women didn't. So, when the check came home, women controlled it. But, when it was in wages, men controlled it.

So, if there's family utility maximization, it shouldn't matter. But it turned out, as soon as they changed the way they paid it, spending on kids went down, and spending on drugs and alcohol went up because, basically, guys don't care about kids as much as women do. Sorry, guys. It's just-- I don't know what the evolutionary biology is. At least, in the '70s, they didn't.

So that's a rejection of family utility maximization. Who had the dollars actually mattered. It's kind of a neat study for how you think about these theories. So it suggests that, secondhand smoke, probably, people don't perfectly maximize family

utility. So there probably are some externalities, OK? So that's a negative consumption externality.

There can also, of course, be positive externalities. So let's talk about a positive consumption externality. Let's talk about my neighbor.

I don't get along with my neighbor, OK? And, partly, it's because my neighbor has a habit of starting big projects and leaving them half done. And, about 25 years ago, 20 years ago, he started a big project to landscape his yard, created these huge mounds of dirt that I look at directly from my kitchen, and then stopped. So, for 20 years, I've had to stare at huge mounds of dirt, OK?

Now let's think about my neighbor's decision to go ahead and get rid of those piles of dirt. Let's say that that would cost $1,000. So the cost is $1,000, OK? And let's say the benefit to my neighbor from doing so is clearly less than $1,000, or he would have done it. Let's say it's $800. So that's why he leaves those piles of dirt because the cost is $1,000 to remove them, and it's only worth $800 to him.

But what he's not accounting for is, if he removed them, there'd be a positive benefit to me of another $300. So, actually, the total social benefit of removing the dirt piles is higher than the social cost. So, from a social perspective, he should do it, but he doesn't because, privately, it's not optimal to do so. So that is a positive consumption externality. Yeah?

STUDENT: Does this mean you'd be willing to pay him like $200 to do it?

JONATHAN GRUBER: Well, this leads to a very deep question, which is can't all externalities simply be internalized. Let's take this example. Why can't I just go over and offer to pay him, OK? Well, and, in fact, with any example, we can do that. Why can't the fishermen just go pay the steel plant, OK? Why can't you pay me not to smoke in class, OK?

Indeed, with any of these externalities, there's a question why can't they all be internalized. And, indeed, there's a school of thought, which suggests that externalities aren't really a problem. They can all just be internalized. But, of course, that's totally wrong, OK?

Let's start with a hard example. Let's talk about the biggest environmental externality, which is global warming, OK? With global warming, every single time

you drive, you are bringing people of Bangladesh that much closer to being under water. How could you possibly negotiate that? How could you possibly negotiate where the people of Bangladesh would come and say, well, drive a little bit less so I don't go under water? OK, that's not happening, OK?

But, even with these simple cases, think about this. Why can't I just go to my neighbor and offer him $200? There's three problems.

First problem is there's the fact that I don't really know what his costs are and what his benefits are and that I might-- I don't want to offer more than I have to to get him to do it, OK? The second problem is he doesn't know how I feel. So there's an information asymmetry, which makes negotiations hard.

There's a third problem too, which is it'd just be deeply weird to do that, right? I mean, it's just not how society works. You think about a classic case of an externality you've probably all run into, which is your neighbor playing their music too loud, OK? If your neighbor plays their music too loud, that is an externality on you, OK?

Now, in principle, you could go to your neighbor and say, well, look, I'm studying for a test. This test will raise my grade by 10 points. A higher grade in this class will raise my earnings by $1,000. So I'm willing to pay you $83 to stop playing music because I've calculated my lifetime earning effect of your playing the music. OK, even at MIT, that would be sort of deeply weird to do.

So what do you do? You either shut up about it, or you go yell at them. OK, but yelling induces-- it's not necessarily an efficient way to resolve it because maybe they really want to play the music. The efficient thing would be, if it's worth more than $83 for them to play the music, they should get to play it and just pay you $83. But, in fact, that doesn't work.

So, in fact, private solutions to these problems simply do not work, OK? It's just hard to figure out how you can really get people privately to internalize these externalities because negotiation is difficult and because it's just socially awkward.

There is a famous apocryphal story told of a famous economist who was on a flight and wanted to get work done and couldn't because the person next to him wouldn't

stop talking. So they actually offered them $10 to shut up. I don't believe that actually happened, but, you know, it makes for a good story, OK? So that's a positive consumption externality.

Finally, we have positive production externalities. The classic example of a positive production externality is R&D by private firms, OK? When a firm does research and development, they don't just create learning for themselves. They create learning that might benefit other firms as well, OK?

And, indeed, the best economic estimates suggest that the social returns to $1 of R&D are 2 and 1/2 times the private returns, that every dollar of R&D a firm does benefits society by 2 and 1/2 times how much it benefits the firm. And, as a result, firms under invest in R&D, OK? As a result, firms under invest in R&D, OK?

And they are-- and that's leading them to-- that's leading to too little R&D being done in society, and that affects all of us because that affects growth. That's what my new book *Jumpstarting America* is all about. It's about why we need the government to come in and invest more in R&D because firms under invest, OK?

Essentially, firms don't account for the spillovers that their investments have on others. So a great example used in the book is the example of when two drug companies were racing to invent statins. You guys are too young to know about statins, but statins are basically a cholesterol-lowering drug that's a miracle. It saves hundreds of thousands of lives every year. Best guess is about 200,000 lives a year are saved by people lowering their cholesterol through being on statins.

Statins were being invented in the early 1980s by two rival drug companies, Merck in the US and Sankyo in Japan. And they were racing to develop these statins. And then Sankyo suddenly stopped. And Merck found out through the grapevine it was because some dogs got sick in drug-- in the animal trials.

And so Merck went to Sankyo and said, hey, we heard some dogs are sick. What's going on? Sankyo said we're not going to tell you. You're our competitor.

So Merck offered to pay them money. They offered to partner. Sankyo said no way. This is private R&D, and we don't want to share it with you. So Merck stopped too.

Five years later, some academics got permission to run trials on statins. It turns out that what happened to the dogs had nothing to do with the drug. They were fine. It's totally safe. And statins were invented and save 200,000 lives a year, but five years after they should have. Literally, one million people died because there was-- they could not benefit from the spillovers of R&D knowledge, OK? This is an example of what we mean by under-investment in R&D, OK?

So we have externalities can be negative or positive. They can be production side or consumption side. Questions about that? Yeah?

STUDENT: So, regardless if they're negative or positive, externalities still create deadweight loss.

JONATHAN GRUBER: Yes, regardless if they're negative or positive, externalities still create deadweight loss because, if they're positive-- I should-- Jason, just sent me a note. Next year, we should have in the handout a positive graph.

Well, I'll just do it here. I can-- I'm capable of drawing a graph. So let's think about R&D. OK, here's the quantity of R&D, OK? Here's the cost of R&D, the price of R&D.

So basically-- and here's the-- so here's going to be the demand for R&D, OK? Here's going to be the demand, which is private marginal benefit. And here's the supply, which is the private marginal cost, OK?

And let's just say that there's no externalities from actually-- this is a consumption externality. This is a production externality. So, basically, the point is that, when a firm does R&D, they do it until the benefits to the firm equal the costs to the firm. So they do an optimum-- they do an amount of R&D of, you know, Q1 at a price of P1.

But what they're missing is that, in fact, what they're missing is that the costs to them are actually well below, well below, what it truly costs because they are benefiting others by doing it, OK? So the supply curve, the true social supply curve, is down here. The social marginal cost is the private marginal cost minus the social benefits that we get from doing that R&D.

So, as a result, they should be doing Q2 R&D, but they're not. They're doing too little R&D. And that's making a deadweight loss. The deadweight loss, remember, is with reference to the optimal point. This is the deadweight loss.

This is deadweight loss from under producing R&D. The difference between-- no, I'm sorry. I got that wrong. These triangles are always confusing. In the drawing, I got that wrong.

OK, it's the difference being the social marginal cost, between the social marginal cost, and the private marginal benefit. So, basically, let me think about this for one second. This is always a little bit hard to do.

So, basically, there are units-- there are units they under produce. So, essentially, what their-- they should be producing this many units, yeah, between the-- it's where the private marginal-- yeah, it's this. I had it right. That's the deadweight loss, OK? Yeah, so, basically, what you have is you're going to have underproduction of R&D, just like you had overproduction of steel, OK? Yeah?

STUDENT: Why would the social marginal cost go down when the social marginal benefit goes up?

JONATHAN GRUBER: Because the marginal benefit is what's the marginal benefit of another dollar of R&D. That's basically-- that's, essentially, what's the knowledge created, OK? You could view this either way, but the idea here is I'm producing R&D. I'm not consuming R&D.

This is the benefit of consuming R&D. This is sort of the benefit of society of consuming that R&D. So you think of it as lowering the cost of producing the R&D is sort of the way we think about it, OK? But the main thing is not-- yeah?

STUDENT: So is the marginal change between the social curve and the private curve, is that linear? Or, as it grows--

JONATHAN GRUBER: That's a great question. I'm always making it-- I'm making it constant. I'm assuming marginal damage or marginal benefits are constant.

STUDENT: So, mathematically, whichever triangle you choose is the same?

JONATHAN GRUBER: Yeah, exactly, because I'm making it constant. And, in fact, you could imagine it could be growing or shrinking, OK? Now, with this in mind and realizing that private sector can't solve this for the reasons we talked about, let's talk about the role-- let's

talk about the role of government, government solutions.

So, once again, remember the basic logic of this class, which is that-- the basic logic of the class, which is that if-- the basic logic of the class is that the market knows best unless there's a market failure. If there's a market failure, the private market will deliver a deadweight loss. Now we have to ask can the government actually make it better.

Remember, we talked about monopoly regulation. The government may or may not make it better, OK? Information asymmetries, it may or may not make it better. Same thing with externalities, the government may not make it better.

So let's talk about how the government, in theory, could make it better, OK? Well, there's two ways the government could make it better. One way is by regulation.

So go back to figure 22-1, OK? The government could literally regulate and could say, look, we know the optimal level of steel to be produced is Q2. We're just going to tell you to produce Q2. That's it. Problem solved, OK? We just say, hey, steel plant, we know the optimum is Q2. You produce Q2. Problem solved.

The problem with that is that requires the government to know quite a lot. The government needs to know both the supply and the demand curves to figure out where Q2 is and what they should regulate.

Let's say all the government knows is the damage being done, and let's say the damage is linear, or they can approximate it as linear. Then there's a much easier solution, which is a corrective tax.

What if the government came in and said, look, I don't where demand and supply curves are? I don't really know. It's really hard to figure it out. All I know is that, for every unit of steel you produce, which is a unit of sludge, you're killing $100 worth of fish.

That's what I know. That I can study environmentally, OK? What if I simply tax the steel plant by $100 for every unit of steel they produced? That is, if I imposed a tax on the steel plant--

STUDENT: Don't you mean sludge?

JONATHAN GRUBER: One unit of steel is one unit of sludge in this example. So I'm going to tax every unit of steel they produce, which is the same as producing one unit of sludge, OK? What if I impose that tax?

Well, let's look at figure 22-3. What does that do to the firm's decision, OK? Well, before the government came in, the firm was producing at point A where their private marginal costs equaled the private marginal benefit, which is the social marginal benefit.

Now the government comes in and levies a tax. It levies a tax at exactly MD, the marginal damage. What does it do? It shifts their private marginal cost curve to the social marginal cost curve. It has caused the firm to internalize the externality because now the firm is paying an amount exactly equal to the damage they're doing to society.

So a corrective tax can cause the firm to internalize the externality. Corrective tax caused the firm to internalize the externality, OK? Essentially, a corrective tax by the government can get us to the right answer because it gets firms to do the right thing, OK? It gets firms to pay attention to the social costs, not just the-- not just the private costs.

Similarly, we could do same thing with a positive externality. What could the government do with a positive externality? Yeah?

STUDENT: Subsidize production.

JONATHAN GRUBER: It could subsidize by-- so imagine I knew exactly how much social benefit there was per unit of R&D. If I subsidized the firm doing R&D, then I would lower their costs, right? If I offered them a subsidy of this amount, their cost curve would shift down. I would lower the cost. So R&D would get to the right point.

So a corrective tax of the amount of damage gets firms to internalize the externality. A corrective subsidy of that amount gets firms to internalize the externality or individuals to externalize the internality. And we can get to the optimal outcome by the government imposing a corrective tax or subsidy of the right amount.

Now we could of course also get there with regulation. It's just a lot harder. Questions about that? OK, this is our first example of good taxes, OK?

Taxes have been bad throughout this course. The role of taxes has been distortionary to the economy. We haven't talked about it a lot. We'll talk about it more in a couple of lectures. They've been distortionary to the economy.

This is saying, no, a tax can actually play a positive role because a tax can correct a market failure. Now, as always, if the tax is set incorrectly, it could make things worse. OK, if you set a tax that was five times the marginal damage, it would make things worse. But, if you set it correctly, it can make things better. We're offering the potential for government intervention to make things better here. Questions about that?

OK, so what do we have? We have a situation where the private market is not delivering the optimal outcome. The private market is not delivering the optimal outcome where it seems hard to think of private solutions, but where a government solution, either through regulation or easier corrective taxation, can get us to the optimal outcome.

So now let's ask how does this actually work in practice. And let's talk about two examples. Let's talk about environmental externalities and health externalities. Start with environmental externalities. And, of course, the most important is global warming, OK?

Currently, the amount of carbon dioxide in the atmosphere is at its highest level in 400,000 years. Basically, every year becomes the hottest year on record almost linearly. Almost monotonically, every year is the hottest year on record. We're heating up. Scientists predict that it's possible-- the central prediction is that temperatures will rise by more than 2 degrees Fahrenheit by the end of the-- I'm sorry, by more than 2 degrees Celsius by the end of the century, but it could be more than that.

There's actually, currently, the best estimate is that there's as much as a 10% chance that temperatures go up by 10 degrees by the end of the century, which would end human life, basically, in most of the world, OK? There is a non-trivial chance we're all gone by 2100, not my problem, largely not your problem, certainly

your kids' problem, OK?

OK, by and large, we are basically-- we are basically-- we have a-- we know for sure there's going to be negative implications. Basically, we are essentially-- unless there's a radical new technology invented, Bangladesh is gone. It's over for Bangladesh. Cape Cod is gone. Much of Florida is gone. That's already happening, OK?

At this point, the question is can we actually stop the entire East and West coasts and much of the South from disappearing as well and many other countries in the world from disappearing, OK? That's the sort of decision we have to make now, OK?

So, basically, this is a classic negative externality because, that negative situation, you were not thinking about that when you filled up your car last time. You're not thinking about the fact that the fossil fuels you're emitting are contributing to that, OK? It's a classic negative externality.

So what can the government do? Well, the natural solution would be corrective taxation. The natural solution would be to have a carbon tax, to literally say this is the amount-- we actually have a pretty good sense from engineering models what the cost of carbon is, what the marginal cost of carbon is, OK? And we could literally impose a tax on the use of carbon of that amount.

I think it would amount to something-- I don't know the numbers these days. It's something like between $0.25 and $0.50 a gallon of gas. So it's a lot, but it's not-- we've seen gas prices in the last year go up and down by that much. OK, that's not an outrageous amount, OK? In Europe, they already have gasoline taxes well above that level, OK?

So corrective taxation, in principle, could be the answer. We could literally just use engineering models to compute the costs, social costs of carbon. We could put a tax on it. And then at least we would stop global warming going forward. You know, Bangladesh may be gone, but we can maybe save a lot of the rest of the world, OK?

So that's in theory. In practice, in 1994, Bill Clinton proposed a $0.03 gas tax and lost Congress, OK? In practice, people don't like gas taxes. It's very hard politically in the US and other places.

And that is why the world has turned to a different approach, which is quantity regulation, which is say, look, in practice, we should have a global carbon tax. In theory, we should have a global carbon tax. In practice, that's hard. That's why we have negotiations. That's why we try to have a global negotiation to try to get a global cap on carbon emissions, actually have a quantity regulation, to actually have a quantity regulation.

We started this. The first true global negotiation was in Kyoto, Japan in December 1997. I was fortunate enough to be there for that negotiation. I was in the Clinton administration at the time. And we got to go over and do that negotiation.

It was actually pretty neat because they decided I was going at the last minute, and the only plane left to go on was Air Force Two. So I got to fly over with the vice president on Air Force Two, which was pretty cool, super cool. They have really nice seats and stuff.

And so I sat down, and the phone next to me rang. And I was like-- I answered it. I was like hello. They're like, hey, John. I'm like oh my god. It was them calling from Japan, but like getting a personal phone call on a plane was super cool.

So, anyway, so I went over to Kyoto. I learned how these negotiations work, which is, over five days, I slept four hours. In Japan, they sell-- they sold, at the time, this coffee in cans. So you just chug these cans of coffee all the time and stay awake. And, basically, everyone is so tired by the end they just agree just to kind of get it done. And that's sort of way that negotiations work.

So we agreed to the Kyoto global warming treaty, which would have lowered emissions worldwide, but the US did not sign on. The US refused to sign on. There's been continuing negotiations. Most recently, we know about the Paris round of negotiations, which the US did sign on to, but the current administration has pulled us back out of.

So we have a problem, which is that, basically, we're heading to this environmental catastrophe, and the world can't agree on actions to take. And it's not really a choice. I mean, we have to do something, or our grandkids will all be under water, or our great-grandkids will all be under water. We have to do something.

The optimistic case that we'll do something comes from the example of what's called chlorofluorocarbons. When I was a kid, many, many products were made with what's called chlorofluorocarbons. They were in refrigerators. They were in aerosol sprays, et cetera.

Scientists realized they were actually damaging the ozone layer, which protects us from ultraviolet rays from the sun. And people were like, yeah, whatever, much like they are with global warming now, yeah, whatever. But then a fucking hole opened up in the ozone layer. Like, literally, it was like, oh my god, there's a hole in the ozone layer.

And 180 countries got together almost overnight and banned chlorofluorocarbons. Like, literally, almost overnight, they were gone. It was amazing, international cooperation, terrific international cooperation to take an environmental catastrophe on and deal with it.

The problem is global warming doesn't quite work that way, OK? By the time we say, oh my god, Bangladesh is under water, it's too late. So the question is sort of how do we get politicians and the public interested in taking something on when we don't have the symbol, like a hole in the ozone layer, to actually represent the damage that's being done. And that is the challenge facing something like global warming, but we have to take it on, OK? So that's environmental externalities.

The other big type of externalities are health externalities, are health externalities. I talked about smoking, but, indeed, there are huge externalities levied by a bunch of activities that we do that impact our health. So, for example, drinking, drunk driving causes 13,000 deaths per year, 13,000 deaths per year, OK, to put a sort of blunt face on it, four 9/11s every year from drunk driving plus 400,000 injuries every year from people driving drunk.

Consuming gasoline, global warming is a huge externality. Perhaps one of the biggest externalities facing us, the biggest social externality, is obesity, OK? Obesity causes a lot of illnesses that cost a lot of money. Projections are that children born in the year 2000, so about your kid, about your generation, one third of them will get diabetes before they die based on current weight projections.

Now, as you notice, looking around this room, that's not a problem of the elite East Coast people, OK? It's not a problem of-- it's a problem of the less educated. It's a problem concentrated more in the South, but, nonetheless, if you look at a number of southern states, the obesity rate is above 35%. Literally, more than one in three people in the state are obese, OK? This is a huge problem, and it's going to cause huge social-- it's going to have huge social consequences for our country.

The question is what do we do about these. What do we do about things like smoking and drinking and obesity? And there's essentially-- there's, essentially, four answers. The first is information. Can we just inform people about the damages?

And, indeed, this has been shown to work with smoking. OK, we knew smoking was bad for you in about 1954, OK? But we only really got through to people starting really in the 1970s and '80s, but it's had an enormous effect. Smoking has fallen incredibly in the US through that information.

But here's the interesting thing, OK? Smoking rates-- smoking used to be 50% in the entire-- every adult, 50% of all adults smoked. It didn't matter race, gender, class, whatever. Now smoking is essentially down to zero among the well-educated and still about 20% against the less educated. So information works, but it works in a very inequitable way. OK, so information is one solution.

The second solution is taxation. And, indeed, this has been shown to work for cigarettes once again. Smoking is price sensitive. The elasticity of smoking with respect to the price is about minus 0.4. About every 10% you raise the price of cigarettes, there's about 4% less smoking. It works.

In particular, youth smoking is very price sensitive. Youths are very price sensitive because youths have less money. So they're very price sensitive. So it actually works.

But that's sort of the easy case. Taxing cigarettes is easy because every cigarette is bad for you. Taxing alcohol is trickier because, after all, most of the damage is done by a tiny share of drinkers. Most of us will consume alcohol responsibly most of our lives and not cause any external damage, OK? But most of the damage is done by a tiny share of drinking.

So taxes is trickier. If I proposed a big rise in alcohol taxes, people would say wait a second. I'm responsible drinker. Why are you taxing-- why are you taxing me? So that's a little bit trickier. Not to mention obesity, taxing food is maybe the trickiest of all, OK? So taxes are trickier.

You could maybe try-- an alternative thing you could do is penalties. So, instead of taxing alcohol, we could just steepen the penalties for drunk driving. You know, if you killed a few drunk drivers, there would be less drunk driving, OK?

But the problem is that's a pretty extreme penalty. And what if you got it wrong? You'd feel kind of bad about killing someone because the breathalyzer didn't work. There was a series of articles, actually, in *The New York Times* about how terrible breathalyzers are and how inaccurate they are, OK? So problem with penalties is we can't enforce them perfectly, OK? So that's the third solution.

The final solution and the one that's really most discussed right now is illegality. What if we just made these things illegal? And this comes to the discussion of marijuana. Should marijuana be legal, OK? Well, illegality is an extreme form of lowering externalities.

Now, obviously, when pot is illegal, people still smoke pot. But it's still true, when you make it legal, it's consumed at much higher levels. OK, legality does matter.

So, for example, people have done studies. Yes, people under 21 drink, but, literally, if you look at people the day after their 21st birthday, they drink much more than the day before their 21st. Not on the 21st birthday, that's the party. We ignore that. But, the day after their 21st birthday and thereafter, they're drinking at much higher levels than before. Legality matters, OK?

It's also true, the day after a 21st birthday, people are much more likely to die in a drunk driving accident than the day before their 21st birthday, OK? So legality matters.

So the point is we have a whole series of tools to think about this. And the question is how should we combine and use them. And the answer is take 14.41, and I'll teach you all about it.

But we don't any more time here. This just raises the issues to think about with

externalities. It's an important topic to think about it. I realize that's a lot to cover in one lecture, but I just wanted to sort of give you a taste for how economists think about and analyze this kind of market failure.