[SQUEAKING]

[RUSTLING]

[CLICKING]

JON GRUBER: OK, today, we're going to finish chapter 5. Let me just say, last lecture was, in my 33 years at MIT, one of the most active interactive lectures I've ever delivered. So you guys are great. I really hope you'll keep it up.

This course is going to be so much fun if you guys keep asking questions, interacting. Just the broad spread of people, the questions I got were great, so please do keep it up. We're going to have an awesome semester if you guys continue to do that. I really appreciate it.

OK, so we're back to chapter 5. And you remember, we were talking about government interventions to address externalities. And I said, look, at the end of the day, price and quantity restrictions are pretty much the same.

I said there were two big differences. One was quantity restrictions involve more information because you don't only need to know how big the externalities. You also need to know the shape of the demand and supply curves.

And I said quality interventions also can lead to allocative inefficiency if firms are heterogeneous. But we solve that problem with the cap and trade system. We talked about how a cap and trade system can solve that particular problem with quantity solutions.

There is a third difference between quantity and price solutions, which is actually-- not that one's better than the other, but the third critical difference. And this is due to a very important article written by Marty Weitzman, a former economist at MIT and Harvard. He made a very important point about how once you have uncertainty in your model, then there are different advantages of costs and price approaches to dealing with negative externalities.

So to see that, we're going to look at figure 5-10. It's the last figure from chapter 5-- figure 5-10. Figure 5-10 is the same pollution reduction framework we used last time.

The difference here is twofold. First of all, we're no longer going to have a flat marginal damage curve. Many of you asked, does the marginal damage curve have to be flat? No, it doesn't. And here, we're going to have a declining marginal damage curve, which makes sense.

The first unit of pollution is the worst, and it gets slightly less bad after that. Not necessarily, but it's a sensible starting point, at least over relevant range. So that's the first difference. You'll see it's a declining marginal benefit curve.

The second difference is we're going to add uncertainty. And in particular, we're going to have the very realistic case of uncertainty over firm cost curves for pollution reduction. After all, let's say you're a regulator and you want to know about firm cost curves for reducing pollution.

You could do some engineering model, which will be uncertain because every firm is different. You could ask the firm. But the firm of course, is going to say, oh, it's incredibly expensive to reduce pollution.

It's going to cost me bazillians of dollars. You shouldn't make me do it. You can't get reliable information from them. So you're going to face an uncertain environment in which you're measuring the cost of pollution reduction

That is what we're capturing here, and we're going to do it in two examples. The first example is climate change, which we'll talk about a little bit more later in this lecture. And the second is forest fires.

The big difference between the two is the steepness of the marginal demand curve, or the marginal damage curve, or the social marginal benefit curve. With global warming, every unit of carbon does damage. But it's not like a particular unit tips us over.

Now, we're getting closer to tipping points with things like Arctic melting. But in general, we don't really care if you drive 100 miles or a million miles this year. That's not going to really affect the future of the Earth.

With forest fires, that's another negative externality. You set a forest fire, that affects other people. And there, certainly there can be very steep marginal damage as forest fires get bigger, that can do exponentially more damage. So that's a steep marginal damage curve.

Now, I'm just picking these examples. I'm making them up. The main point is you want an example with a flat marginal damage curve and a steep marginal damage curve.

So those are two examples. In each example, we're going to have an MC1 curve. MC1 is the government's estimate of what the marginal cost looks like MC1 is the government's estimate of how much a marginal cost of reduction actually is. MC2 is the truth.

So MC1 is what the government thinks the marginal cost of reduction curve is. MC2 is the true marginal cost of reduction curve. Questions about the setup?

OK, let's now look at what happens when the government either puts in a tax or quantity regulation based on what it thinks is the true marginal cost of reduction. So in the case of climate change, let's take the quantity regulation. The government rolls in and says, look, we think the right cost curve is MC1.

The benefit curve is SMB. We're going to assume no uncertainty in that to make life a little easier. Those two intersect at point C. And that says that the optimal reduction is R1. That's just applying the framework we did last time.

Now in truth, the marginal cost curve is MC2. So the true optimal reduction is where MC2 hits the social marginal benefit curve, which is that R2. It's that R2? So the government, by getting it wrong, is reducing too much. There's too much reduction.

Remember the key point last time. You can have too much pollution reduction. Fully getting rid of pollution is never optimal. Because why would you have too much pollution reduction? Because the costs you're imposing on firms to reduce pollution are greater than the benefits to society of having them reduced.

So what you see here is the government, through its quantity regulation, is creating a deadweight loss DWL1. DWL1 is units where the true marginal cost, the red line, is above the marginal benefit. So those are all units where the marginal cost of reduction is above the marginal benefit. And yet, you're still mandating reduction. So you're creating a deadweight loss by mandating too much reduction. Questions about that?

OK, now let's think about an alternative policy tool, which is a tax. Imagine I know the marginal damage curve, the social marginal benefit curve. But I still don't quite know what the right cost curve is. So I set my tax thinking that marginal costs are MC1.

Well, where do I set my tax? I set my tax at the level C2. That little t equals C2 on the y-axis. I set my tax there.

When I set my tax there, I am saying to firms that's the tax they're going to have to pay. In fact, the tax they should pay is where-- let me be very precise on this. So I set the tax where marginal cost equals marginal, MC1 equals marginal benefits. So I set it at point C.

Where it should be is where marginal cost equals marginal benefits, MC2 equals marginal benefits. The government is going to set a tax at that little t. And that's what they're going to tax.

The firm, the optimal tax would be different than that. The optimal tax would be at B where MC2 equals marginal benefits. That would be the optimal tax. So the optimal tax would be slightly higher, where the optimal is slightly higher.

So what happens here? Well, the firm should choose point B. Instead, it chooses point E. Why does it choose point E? Someone tell me, why does the firm choose point E when we set this tax equal to little t. Yeah.

AUDIENCE: [INAUDIBLE]

JON GRUBER: Yeah. So basically, there's no reason to reduce less than that because that's the marginal cost of reduction. That were reduced to the point where the marginal cost reduction equals the penalty they have to pay. That penalty is little t. So they're going to choose to reduce to point E.

The optimum is B So they are doing too little reduction. The optimal reduction is R2. They're doing R3, creating a deadweight loss of the triangle to the left DBE.

Now let's contrast that to what happens to forest fires. Let's walk through the same steps a little faster now. The government thinks that the optimal quantity to regulate is R1. The true optimal quantity is R2. So the government causes too much reduction, creating a deadweight loss to the right of point B, the triangle ABC.

The tax case-- the government thinks the optimal tax is little t. But little t hits MC. But in fact, the optimal tax should be higher. So that means they do too little reduction.

In other words, the area BDE is the area where the social marginal benefits of reduction are above the cost of reduction. So that's why they're doing too little. In both the top and bottom panel, the tax caused them to do too little reduction because the social marginal benefits are above the true social marginal costs. So it's a deadweight loss, which arises from doing too little reduction.

Let me stop there. Do people understand? Questions about this complicated graph?

Questions about this? OK, here's the money question. Notice the key contrast between the two-- yeah, question.

AUDIENCE: The marginal cost curves that we have here, [INAUDIBLE] are [INAUDIBLE] firm

JON GRUBER: To the firm. Well, basically, these are private marginal cost curves. These are private marginal cost curves. Now remember, when we're doing-- in this framework, we're not doing social. The marginal cost is the marginal cost of reduction.

So the private and social marginal costs are the same because we're assuming no externalities in the reduction of pollution. So marginal cost curve is just marginal cost of reducing pollution. We're assuming that costs are the same in the firm as it pertains to society. Yeah.

AUDIENCE: Can you explain one more time [INAUDIBLE] firms where the [? reduced ?] tax [INAUDIBLE].

JON GRUBER: Would we switch to point E? Because the firm's decision is-- remember, the true MC is MC2, the red line. They see a tax of little t. So you said point E instead of point-- OK.

Well, why would a firm facing a tax of t not go past E? Why would it go to B? If it goes to B, it's spending more than paying the tax. Because look, if it goes to B, its marginal cost is above the tax.

So why would it do that? It would rather just pay the tax. So it will only reduce until the intersection of that line, which is point E. Does that make sense?

AUDIENCE: Yes.

JON GRUBER: OK. Yeah.

AUDIENCE: So the deadweight loss one would only occur if and only if the mandate and deadweight loss two would only occur if and only if [INAUDIBLE].

JON GRUBER: Exactly. Yes, that's a great point. Excellent clarification. OK, here's the money question.

Notice that the deadweight loss on the left is smaller than deadweight loss on the right on top, but bigger on bottom. Any intuition for why? This is hard.

Any intuition for why the bottom case? In other words, in the top case, quantity regulation causes more inefficiency than price regulation. In the bottom case, price regulation causes more inefficiency than quantity regulation. Why? Yeah.

AUDIENCE: It's due to the elasticity of [INAUDIBLE] curve [INAUDIBLE].

JON GRUBER: That's what's causing it graphically. But what's the intuition? And that's causing graphically the elasticity. But what's the intuition for why? Yeah. [INAUDIBLE]

AUDIENCE: Better [? to ?] prevent forest fires than under prevent.

JON GRUBER: Yeah, exactly. Think of it this way. Think of quantity regulations as erring on the side of the regulator and price regulation as erring on the side of the regulated. So the quantity regulation, the regulator is saying, look, I don't care what it costs you. You're doing x.

With a price regulation, they're saying, I don't care how much you do. Just do it till it costs y. So quantity regulation is about getting the quantity exactly right no matter what the cost is.

A price regulation is about saying, look deal with the externality and we get what we get. In the first case, we don't really care about getting exactly right. It's a very flat curve if you're a little bit off. If you drive 500,000 miles, instead of a million miles, it's not going to affect the future of the Earth. In the second case, if you light a big fire versus a small fire, that will affect the future of California.

So we care. The other example I often use here is nuclear waste. There, it's just a vertical line. But that's the most extreme example.

We care in this second case much more by getting the quantity right. So even if we impose extra costs on you, the bottom line is quantity regulation is making sure that the quantity right and saying, I don't care what it costs you, firm. We've got to get this right.

Once again, nuclear waste would be the ultimate example. That's a vertical line. The marginal damage is vertical. A little bit kills us all. Yeah.

AUDIENCE: Is the result [INAUDIBLE] was above MC2 [INAUDIBLE]?

JON GRUBER: If MC2 was above C2, you'd reverse everything. Yeah, exactly. So basically this is an example of a more subtle distinction between price and quantity regulations and another reason why they might be different. It's a very subtle point, but it's a good example of how we can use this kind of graphical analysis. And in section we'll do it mathematically graphical analysis to really understand why you might prefer one versus the other and to deal with a real world.

Look, as I say in 14.01, all models are wrong, but some are useful. What is a model? A model is an abstraction from reality. The goal of any modeling exercise is to trade off the power of a more complicated model against the benefit of a model that's easier to work with.

Until this point, we've abstracted away from uncertainty. That gave us a lot of interesting lessons. Now I add uncertainty and you'll learn a new lesson, but at the cost of 25 minutes.

So basically, the challenge we face is how to think about these things. And this is an example of a deeper dive that one might do if one wanted to really get into this. More questions about that?

All right, now we move on to chapter 6. And what we'll do in chapter 6 today and next time is talk about externalities in reality. And we'll focus on the two key areas where externalities are a focus of government policy, the first being environmental externalities and the second being health externalities.

So we'll start with environmental externalities. And we're going to focus in particular on two kinds of environmental externalities. The first is particulates emission.

Now, I'm sure there are people who understand the science here way better than me. So excuse my rudimentary chemistry. But roughly speaking, when we burn coal to make power, we release sulfur oxide and nitrous oxide into the atmosphere. They then combine with oxygen to make bad stuff, in particular to make acid rain, which is rain that comes down, that's bad for the environment.

It's not that bad for humans. More importantly, they create particulates, which are soot, which is in the air and which can harm us when we breathe it. In particular, very fine particulates, which can get into our lungs, are very damaging to people.

As a result, there are enormous health consequences of burning coal. We know burning coal is bad for the long-run health of the Earth. But it's actually bad for the short-run health of us.

When you burn coal, it can cause asthma. It can cause other health problems. And I'll come to those in a few minutes.

Now, the problem is they burn the coal in the Midwest. And the soot then floats in the air and falls on the East Coast. So it's a classic steel plant and fisherman problem, which is the folks burning the coal-- not only is it many folks burning the coal and many folks being affected, not even the same folks.

So it's a classic case where it's going to be very hard to envision a Coasean solution to this problem, because they're not only disparate in terms of who's doing it. They're separate geographically. And that's why we think we need a government role in dealing with this.

So I want to talk about how has the government regulated particulates, because it's an excellent example of how our thinking on this has evolved. The first effort to do this was in the 1970 Clean Air Act, way, way back, cast your mind way back. And with the 1970 Clean Air Act, it set up what was called New Source Performance Standards.

They said, look, we got a bunch of bad coal plants. What we're going to do is make sure that we never make this mistake again. And any new coal plant that's built has got to be much more environmentally protective.

You've got to install scrubbers. You've got to do all this stuff to make sure you're not emitting all this bad stuff into the atmosphere. It's not that you can't build a coal plant. We're just going to make it much more protective of the environment.

And that was a major bill that passed the passed in the 1970s. And we did see some declines, in particular in sulfur dioxide that caused particulates. We saw declines.

But it wasn't a huge effect. And why is that? What's the fundamental challenge if you try a regulation like this?

Let's say you're a power producer in Ohio. You've got your coal-fired plant. I pass this new source performance standard. What are you going to do? Yeah, in the back.

AUDIENCE: [INAUDIBLE]

JON GRUBER: Yeah, so basically, think about an optimizing coal power plant owner. He's constantly thinking, should I upgrade or should I build a new plant or not? What we've done is just taxed building a new plant.

We've just said, look, if before you were indifferent, you're about to build a new plant, now don't build it. That's what it costs just keep running your old ones. Guess what? The old ones are really bad for pollution.

So essentially, this offsetting effect, which is we incentivize keeping old plants running. Essentially, it offset the pollution gains from these New Source Performance Standards. While new source performance standards helped, they didn't help that much these offsetting effects.

So this is not just an example from my childhood. This is relevant today. We want to replace our fossil fuel-using vehicles to electric vehicles.

What happens to all the old fossil fuel-using vehicles? They don't just disappear. What happens to them?

They get shipped to developing countries. So all these used old fossil fuel-burning vehicles that we're now replacing with EVs get shipped to developing countries. And a bunch of people who weren't going to drive now drive fossil fuel-burning vehicles, offsetting the benefits of switching to EVs.

This is a classic problem. We call it a problem of partial regulation, which is when you try to sorta, this is always a game of whack-a-mole. And when you try to solve one problem, you might create others you don't anticipate.

And that's probably one of the greatest victories of all time for economics. In 1990, under the first President Bush, a series of economists, including our own Richard Schmalensee, former dean of the Sloan School, convinced the Bush administration to pass a set of amendments to the Clean Air Act in 1990. And these amendments did two things. First of all, they dramatically tightened the standards of what could be emitted. But second of all, they set up the nation's first cap and trade system.

They said, look, we are now going to say every-- I'm sorry, three things. First of all, they tightened the standards. Secondly, they applied them to every power plant, not just new ones. And third, they allowed trading. They said, we're going to have a new cap for U utility.

Jon's Coal Plants of Ohio, we're going to have a new cap on how much you can produce overall from all your plants. But we're going to allow tradable permits. This was the first example of tradeable permits.

As I said it was super-controversial. There was this concern over pollution absolution, that essentially we're permitting bad behavior. We should just tell them all to stop, not do this. But in fact, it's much more efficient. It's a much more efficient way to do it.

Plants could then basically-- if we go back to our example from last lecture. Indeed, if you flip over this page-- I think we still have the graph. Yeah, it was of the graph from last lecture on the back of the chapter 5 page. If you go back to the chapter 5, handout there's a graph from last lecture.

So Paul, you were smart. You thought ahead in printing this out. Basically, when we have heterogeneity in the cost of reduction, then it's going to be beneficial.

Rather than forcing plant B to spend a ton and plant A to get away cheaply, by letting them trade, we move to the efficient allocation as we discussed last time. So this was, in some sense, the economist's argument for having your cake and eating it too. We could regulate more and reduce economic activity less by having this trading system, and get rid of partial problem of people just keeping old plants running.

Now, this predictably raised a lot of opposition. One form of opposition said was from environmentalists who felt it wasn't pure enough. The other opposition, of course, was from the industry who said, look, you're going to crush us. You're going to destroy coal.

It sounds familiar. It's current modern debates as well. You destroy the coal industry with these regulations. No one will use coal anymore. It's horrible.

We'll lose-- I think the estimates the coal industry point out-- by the way, never trust an estimate from a regulated industry about what something's going to do to that industry. I don't think you need to be a genius to figure out why their incentives aren't aligned to give you a correct estimate. They estimated that there would be a $7.4 billion annual loss and four million jobs would be lost, which is probably more than what was in the coal sector at that time. And so they said that it would be bad.

But in fact, this has been an enormous success. In fact, what we found is two things. First of all, studies of the Clean Air Act have found enormous benefits for human health, benefits for studies of everything. There's really cool studies of the Clean Air Act.

The simplest studies were of the form-- something like figure 6.1. Let's look at the original Clean Air Act. So you covered chapter 3 in sections there's an application of chapter 3 methods. This is by the nation's leading environmental economist, Michael Greenstone, who used to teach here and now teaches at Chicago.

Here we have a situation where there were areas that were similar. Some were regulated, some were not. Errors are similar, some are regulated, some were not.

So basically what he said is, there are some areas that are similar. Some were just over a threshold when they were regulated. Some were below that threshold when they weren't regulated.

And he looked at what happened over time to basically pollution in areas that are regulated or not regulated. What he finds is the regulatory pollution dropped a lot. So in non-regulated areas, things didn't really change. That's the green. And the regulatory pollution dropped a lot.

And guess what else? So did deaths. Those are dramatic reduction in deaths.

So there's a number of studies of that. But there's also really cool studies that go beyond that. So for example, one of the coolest studies I know is, they looked at what happened to kids who lived near toll booths before and after E-ZPass.

You guys know E-ZPass lets you whip through the toll. When I was a kid, you used to have to pay. There were long lines of cars at toll booths, which meant more emissions.

So basically, E-ZPass meant suddenly, these kids were exposed to less emissions because there weren't long lines of cars idling, waiting to pay. And they found measurable improvements in child health. There's all sorts of cool papers like this. It's one of the most active and exciting areas in empirical economics. There's all sorts of interesting, exciting papers showing the enormous health impacts of reducing particulates, either through this regulatory mechanism or other mechanisms.

Now, on the other hand, it did cost something. There was a loss in economic activity because we did lose some coal jobs and some production. And also it raised the price of fuels. Basically, what we're doing is-- [INAUDIBLE]. So what we're doing is essentially making it more expensive to use fuel products that is going to lower economic activity.

The best estimates are that if you take the health benefits, and you value them in a way we'll discuss in chapter 8, the benefits of this law was about seven times its cost. And that seven times was largely because of the trading. Basically, trading lowered the cost of implementing this law by about 2/3.

Basically, absent trading, the Clean Air Act, to achieve the same goals, would have cost three times as much. And so the benefit-cost ratio would have been closer. But because of trading, the benefit-cost ratio was-- the benefits exceeded the costs. Question.

AUDIENCE: For the purpose of this class, do we care about who bear the costs and who gains the benefits?

JON GRUBER: Great question. Now we don't because we're not about distribution. For the purpose of the class, we do. But it's always very important to separate distribution and efficiency. Now we're just talking about efficiency.

Later, we'll talk about that. I mean, we can come to it here in a second, which is in some sense, if you think about that, you can take a model like this-- we talked about social welfare if you reviewed your chapter 2. You could take a model like this and add social welfare weights.

Social welfare weights are essentially-- if you think about a utilitarian social welfare function, a poor person has a higher weight than a rich person because each dollar means more to them, has a higher marginal utility of consumption. You can add welfare weights. If you add welfare weights, that only strengthens this argument because generally the pollution was the worst in the poorest neighborhoods. And the costs were generally borne in by higher-income owners of coal plants and fairly wealthy workers in those coal plants. So that would only strengthen the conclusion if you add distributional concerns. Yeah.

AUDIENCE: How is it that permits [INAUDIBLE] for legislation [? like ?] that, how does that [INAUDIBLE] actually get distributed among [INAUDIBLE]?

JON GRUBER: That is an awesome question. I'm going to come to that in a few minutes. Other questions? Yeah.

AUDIENCE: [INAUDIBLE] also we spoke last lecture about there is [? some ?] benefits to using direct taxing or pricing of the negative thing, rather than capping and trading. Why is [INAUDIBLE]?

JON GRUBER: Same question, I'm going to come to that. I have about a five-minute spiel on this that you're absolutely previewing. But to get to that spiel-- other questions about this?

Let's turn to the next topic, which is really the most important environmental externality in the world, which is global climate change. Basically, I have this saying because I'm a health economist. I say there's only two things that matter in the long run, which is climate change and health care costs, because in both cases, we're underwater. Basically, global climate change is real. It's caused-- even Trump didn't deny that last night, that it's real and man-made.

And it has enormous consequences. The world is getting hotter. Last year, 2023-- if you look at degrees Celsius above the 20th century average, in 2022, we were about 0.91 degrees Celsius above the 20th century average.

In 2023, it jumped to 1.2 degrees Celsius above. That is an enormous jump. I mean, that's incredibly consequential, and there's no sense of it slowing down. We are facing an enormous and rapidly growing problem of global warming.

Now, if you live in North Dakota or northern Minnesota, it's not necessarily so bad. Indeed, it's not even clear that we were before that 100 years ago was at the optimal global temperature. It's not entirely what the optimal global temperature is. If you look at total world production, we may actually be closer to it now.

But what's clear is we're going to go past it very rapidly. And things like Bangladesh will be underwater, Cape Cod will be gone, Florida will be gone, things which might make us sad. These are enormous consequences.

World GDP by 2100 will be 10% lower. Literally, we're burning 10% of all our resources through climate change. And it's obviously not distributed equally. Once again, it's some of the poorest countries that are bearing the brunt of this climate change.

But the key thing we've really started to focus on lately is it's not just the long-run global warming, because people don't care about the long run. It's the short-run, salient climate related disasters. And that's why we've gone from calling it global warming to climate change. Or the term I like, someone called it, "global weirding," which is weather has just gotten really weird.

There is both more rain and more droughts. Why is that? Because the rain falls harder and faster than it's absorbed in the dirt.

There's more rain and more droughts. There is more hurricanes. There's more wildfires.

One of the most dramatic examples was, in 2023, an area of Canada burned the size of North Dakota. Some of you in America may have seen the smog from Canadian wildfires. This was an enormous wildfire, one of the biggest on record.

Here's what's amazing. That wildfire also released a ton of carbon stored in trees. So that wildfire, by burning the trees, released carbon. Indeed, the carbon released by that wildfire was more than any other country in the world emitted that year, except for three. So that one wildfire emitted more carbon than any other country, except for three in the world. So we are in this real cycle of damage.

And once again, it's not just about the environment. It's not. It's about human lives and human health.

So for example, there's a huge rise in chronic kidney disease, the cause of kidney failure. Every five degree temperature increase increased the odds of kidney failure by 47% And we are seeing more kidney failure. There is more chronic disease because of this global warming.

The problems are bad. I can go on and on. You guys have heard about this.

It's a problem. It's perhaps the classic non-privately solvable negative externality, because as I said, emissions from anywhere in the world affect everywhere in the world. Literally, you could not design a better fail of Coase than global warming. You need the government to get involved.

Now, the problem is which government? If you look at figure 6-2, this shows the distribution of emissions around the world. This is millions of tons of carbon that are emitted by country.

You see that China, the United States, and India-- China and the United States are well above the rest of the world. And they account for a huge share of the total worldwide emissions. 40% of worldwide emissions are from China and the US.

By the way, when I started teaching this class in 1992, China was negligible. The US dominated every other country. So China, we see-- we'll come back to this, how rapid growth can impact the environment.

So basically, you have a situation where you have an unequal distribution of the emissions, an unequal dynamic distribution and unequal distribution of the damages. So it's not like one country's government can solve this. You need a global solution.

Now, that is very hard. The good news is we have one positive example, and that's the Montreal Protocol. So when I was a kid, there was lots of things that feature what's called chlorofluorocarbons, which are basically things that were in aerosols.

So when you had hairspray as a kid that had these aerosols in it, refrigerators, et cetera. Turned out those aerosols were just creating a giant fucking hole in the ozone layer. And suddenly, this hole just started-- scientists knew about this. But then suddenly, the hole actually emerged, or started to emerge.

And people were like, wow, that's bad. There's a hole. We ought to do something about that.

And 160 nations got together and negotiated a global ban on chlorofluorocarbons. Indeed, the Montreal Protocol was ratified by 184 countries, and worldwide consumption of CFCs over 15 years dropped from 1.1 million tons to 64,000 tons. It worked, and that hole is now on its way to healing.

Recently, the Kigali Agreement, ratified and further expanded it because there's some other CFC-like things that are also bad. And so there's a new round called the Kigali Agreement where they further ban those things. So basically, this is great. This is a good example.

The problem is-- it's the best example for cooperation because there was a hole. Global warming doesn't work that way. Global warming is like a ship that's going slowly. It's going to take 100 years to turn around. So we don't have quite the salience of the hole, but at least we have one example we can point to of international cooperation.

So the question is, how can we get international cooperation? And this led to a series of international conferences, the first one in Rio in 1992, to take on the problem of global climate change. Now, the most significant early conference was the Kyoto meeting in December 1997. I actually was at that. I was in the Clinton administration at this time.

And it's actually an interesting story-- interesting to me at least. And I guess now you have to hear it. What happened was, there was actually a big fight between the environmentalists and the economists. The environmentalists were led by Al Gore. The economists were led by my former mentor, former President of Harvard Larry Summers.

The economists said-- look, remember, we knew way less about global warming in 1997 than we know now. The economist said, look, the global warming thing might be bad. We're still unsure, so let's start slowly. Let's slowly start to regulate and ramp in.

The environmentalists are like, no, the Earth is burning. We got to go hard now. And the environmentalists won. And the US went into a negotiation, which was going to be an aggressive reduction in worldwide carbon emissions.

Now, I wasn't intended to go because I was on the losing side as an economist. But they decided the day before, they needed economists there. So the only plane left the day before was Air Force Two. So they got to fly over in Air Force Two, got to hang out with Al Gore in his sweatpants.

The coolest part was I get an Air Force Two, and there's nice chairs. And I'm sitting, the phone next to me, rings. I pick it up, I'm like, hello?

They're like, Hi, Jon. It's like oh my god, they're calling from Japan to make sure I was on my way. That was freaky.

So we went. It was an incredibly intense experience negotiating this treaty. What I learned is basically, the way treaties get negotiated is everyone just gets so tired that you finally sign it to go to bed.

So I was there for four days. I slept five hours. In Japan, they have vending machines, coffee in cans. So we just drank the coffee in cans all the time to stay up. And eventually, we just signed it because people were tired.

But we signed the Kyoto Agreement, which was a dramatic step forward. It was an agreement to reduce emissions by 2010 to where they're left to below where they'd been in 1990. So those emissions are growing naturally as economies grow. It was a commitment to reduce that growth in emissions.

37 of the 38 countries that agreed to that bill then brought it back to their nations and signed it. We were the one that didn't The US never signed the Kyoto Agreement and never was bound by it. So once again, while chlorofluorocarbon is a great example, it's not uniform. It's hard.

I'll come back to, in a few minutes, why the US didn't sign. But let's talk about a key feature of the Kyoto Agreement, which was that it included emissions trading. And let's talk about how the Kyoto Treaty actually is an excellent example of the benefits of emissions trading.

Basically, all the signatories were allowed to trade emission rates across themselves. So once again, our classic plant A, plant B example, now it's country A, country B. why this matters is countries-- like plan A and plan B had very different marginal costs of production. Countries had very different marginal costs of meeting their global warming targets for very different reasons.

One reason was, take for example Russia. Russia had just collapsed after 1989. Their economy had gone. Growth had been massively negative.

As a result, it wasn't that hard for them to limit emission reductions. They weren't producing anything anymore. It was cheap.

On the other hand, take Japan. Japan had been taking global warming very seriously well before we had. They'd already converted a lot to nuclear and other things, which are very efficient.

It's very expensive for them to do more. They'd already gotten pretty far. So there's huge heterogeneity across countries in the cost of this.

So to make this a simple example, let's go to figure 6-3. And let's think about the world as being the US and the rest of the world. That's how US people think about it anyway, so we might as well do it. We've got the US and the rest of the world.

And let's say there's two marginal cost curves, supply curves. This is the graph for pollution reduction. So the supply curve is the marginal cost of pollution reduction.

You've got a US curve and the rest of the world curve. The US curve is much higher. That is, the marginal costs are much higher because basically, essentially, it's much more expensive.

A, we're growing rapidly in the 1990s, into the 2000s. And B, it's much more expensive to retrofit and tear down plants and build new ones than it is to just grow into it naturally. So we are pretty expensive, in particular compared to places like Russia.

The goal that was set meant a reduction of 440 million metric tons of carbon. That was the goal set in Kyoto. I'm sorry, it was 630. I'm sorry, the target was 630 million metric tons of carbon to be reduced. So one way to do that was to say every country had to achieve the Kyoto goal on their own.

Well, given the distribution of carbon emissions at that point, that would have meant the US would have had to do 440 million metric tons of reduction, and the entire rest of the world would do 190 million. That's just because basically, we're the super bad guys at that point. China, India hadn't really started doing this yet. We're the bad guys, so we had a lot more to reduce.

We just said, in an autarkic world with no trading, the US has to get to the Kyoto target, which was 7% below its 1990 levels, by 2010. It would have had to reduce carbon emissions by 440 million metric tons. The rest of the world, only by 190 million. What does that mean in terms of cost?

That means the US would have had to spend \$210-- would have had to charge \$210 per metric ton of carbon. In other words, if you just put a price, the price it would cost the marginal cost, the rest of the would have been \$20.

Now let me fix ideas for you. \$1 per metric ton of carbon is like a cent on a gallon of gas. So this would be equivalent to a \$2 increase in the price of gas.

That's big. You heard last night, the price of gas is a big part of how we think about public policy. But due to trading, we could fix this problem.

So go to the second panel. Now imagine, instead of each country having to do it on its own, we just have a worldwide supply of carbon reduction. And that's S sub T. That is the sum of the US supply curve and the rest of the world supply curve-- S sub T. What you see is now, to reduce by 630 million units, from a worldwide perspective of only \$50.

So if we had perfect trading and permits over \$50, the US would reduce only by 40 million metric tons, 1/10 as much. And the rest of the world would pick up the slack. Why? Because it was efficient for them to do so.

Reductions were cheap in the rest of the world. They would be happy to pick up the slack if we paid them for it. So with a functioning and efficient permanent market, we cut the cost by a quarter to the US of meeting this target. So this is an example of the power of trading. Questions about that? Yeah.

AUDIENCE: So presumably, that would lead to a smaller increase in, for example, the price of gas in the US. Would the difference between that level and the level that would have been paid in panel A be, somehow or another, still passed on to taxpayers?

JON GRUBER: That's a great question. Once again, I'll come to that. Great question. So that is one example. Other questions about the mechanics here? Yeah.

AUDIENCE: Walk through again the orange curve.

JON GRUBER: Yeah, ST is just the sum of SUS and SR. Imagine, instead of each country doing it alone, there's a worldwide supply.

AUDIENCE: Why would it be?

JON GRUBER: Flatter? Flatter than either of them, because basically, you always do. What's cheaper? If you have an aggregate supply curve, it's always flatter than each firm's supply curve, you could always choose whichever. So basically, you do what other firms do.

But eventually, the US gets cheaper than other countries. At that point, you use the US, and so it's below the other country curve. Does that make sense?

AUDIENCE: [INAUDIBLE].

JON GRUBER: OK, other questions? Good question. Other questions? OK, well, as I said, the US wouldn't sign this, Kyoto. Part of it was $50 was still a lot.

But part of it was the fact that you may know there are more than 38 countries in the world. I mentioned 38 countries signing this. The entire developing world was left out of this agreement. Why were they left out of this agreement?

Well, we knew this was a problem that's going to come. We knew eventually China, India would start to use a lot of emissions. The problem is, they hadn't. And they're like, screw you.

Like, you guys got to party and have air conditioning. We're about to grow and have air conditioning. You don't want us to have it?

You don't want to let us have what you had? Tough luck, buddy. We're going to have it. So the problem with developing countries-- and I was in the room negotiating with them, and they were very dismissive of this whole enterprise. We're like, look, why should we play?

The problem is that getting developing countries to play would be enormous. Indeed, if the whole world was involved, the cost would fall by another factor of 4. So you get developing countries in, that ST curve would be even flatter. And the cost [? would ?] cost by another factor of 4.

Why is that? Because that's where the cheapest opportunities are, because they haven't built the plants in the first place. If the US wants to improve our fuel efficiency, we've got to tear down a coal plant, and build a nuclear plant or a natural gas plant.

These countries were going to build it anyway. Just build this way instead of that way. That's way cheaper.

So the tremendous opportunity is you bring them in. But they were like, we don't want to play. So how could we solve this problem?

Basically, there's tremendous opportunity of bringing them in. They don't want to come in because they want the air conditioning. What do you do?

AUDIENCE: Pay them.

JON GRUBER: Pay them. And what's a great way to pay them? Say, we are going to set a looser target for you. So instead of you having to get to 7% below 1990, you have to get to 20% above 1990. Why is a looser target equivalent to paying them?

AUDIENCE: It's like giving them more permits.

JON GRUBER: It's like giving them more permits. The looser their target, the cheaper it is for them to reduce. It effectively gives them more permits, gives them more reduction opportunities. So people buy even more of their reduction opportunities.

It's a way to pay them without politically saying, I'm giving China $1 billion. You say, well, I'm just setting up this permit market, and China is going to end up with more permits, and we're giving China $1 billion. So that was how you ultimately try to get them involved. Now, that didn't work. It wasn't part of Kyoto, and really hasn't been part of any situation yet.

Now, we come to this excellent set of questions that were asked, which is what was actually done in the US? And how do we think about the policy trade-offs, which is really fascinating in this context. So the first thing, if you ask economists, or look at the figure from the last chapter, global warming is a classic case where tax makes more sense than a quantity restriction. We showed you the deadweight loss for something with a very flat marginal damage curve is much lower in the case of uncertainty, which is a lot of uncertainty with the tax quantity regulation.

So the obvious thing to do is to have a tax. And since it's been an issue, economists have always called for a corrective tax on carbon. Indeed, as I said, probably the nation's leading environmental economist guy is Michael Greenstone. Well, Michael Greenstone has actually done an incredibly elaborate exercise with a series of collaborators where they've actually measured the social cost of carbon.

They've actually measured the marginal damage curve. They measured the cost in terms of damage to human health, in terms of damage to agriculture. They've literally gone and taken engineering estimates and measured it. And their current estimate is that the social cost of a ton of carbon is more than $200 per ton today. That is, every ton of carbon that's used has an extra marginal damage of more than $200 per ton.

So what Greenstone would say if he were here is-- politics aside, we should have a carbon tax, which is $200 a ton. The problem, as I said, that's $2 a gallon on gas. To fix ideas, the first attempt to go after this was in the Clinton administration.

Bill Clinton proposed a gas tax to get ahead of this. It was an ambitious $0.034 gas tax, and he lost Congress over it. The price of gas is super salient in people's minds. So carbon taxes are just not happening.

Simply, there is a set of things we'll learn about this semester where they have an incredibly dedicated voting block. Unfortunately, that voting block consists only of economists. This is one of them. This one, some environmentalists are on board, too. But the bottom line is it's just too difficult politically.

So that led-- that's your first question of why didn't they do taxes. That led to the Kyoto framework and the general framework of fine. In general, cap and trade is as efficient as taxes. So let's just go to cap and trade. The Weitzman point, we miss.

But leave that aside. That's too complicated. In general, cap and trade gets you to where taxes are. So let's do a cap and trade system. And so the US turned that down.

But when President Obama was elected, he campaigned on global warming as being one of his main issues he wanted to deal with. And under his leadership, they actually set up legislation called the Waxman-Markey Bill, which would have set up a cap and trade system for global warming in the US. So the way this worked, it was called the American Clean Energy and Security Act-- ACES. And how did this work?

Basically, firms would face limits on their emissions. They could do this by reducing their emissions. Or they could purchase pollution credits to offset their emissions.

Now, these emission permits would then be sold in a fluid market and firms could buy them. Ultimately, the idea is the emission permits would essentially be what the cost needed to be to meet our emission targets. They wouldn't necessarily be the $200 a ton, which is optimal. But we have some target to meet, we'll set a price such that we meet that target.

Now there's a couple of issues this raised. The first was, who is going to pay for these emissions, for the cost of pollution. Emission permits is less than what we're polluting today. That means there's costs on people who are going to have to reduce their pollution.

And those costs, typically borne by utilities, would be passed on to consumers. It's the general consensus of economists and politicians alike. And the view was that you would end up with large costs passed on to consumers.

So let's take my utility in Ohio that's super dirty. I'm going to buy a ton of emission permits. Well, I have to pay for them.

How do I pay for them? I raise the price of what I'm charging for my coal, for my fuel, for my power that I'm generating. So basically, you have a situation where there is going to be significant increase in the price.

In fact, that's the idea. If you think about a cap and trade system, it's a backdoor way of getting at the same level of taxation. Remember that. Go back to figure 5-9 on the back of that handout today, remember, the cap and trade gets us to the same level as the tax. So really, a cap and trade is a backdoor way to get a tax, but without calling it that.

Well, people don't like taxes. And they saw through this and said it's going to massively raise the price of energy in the US. Now, the developers of this bill had an answer to that. They said, well, what we're going to do is actually give these permits-- the initial allocation of permits, we're going to give to firms today in proportion to how much they pollute.

So a firm that pollutes a lot is going to get a lot of permits. A firm produces little is going to get. And it's based on past, so it won't distort what it says, it's based on past. And then that way Jon's dirty coal fire plant doesn't have to raise its price as much because it gets a lot of permits.

Well, that was criticized for two reasons. And the CBO said that would lower the cost to consumers a lot. There's two problems with that.

We don't want the cost to consumers to be lower. We want the cost of goods to be higher. That's how you end up using less fuel. That's how you end up using less carbon intensive. It offsets the very goal of the policy.

The second problem is, that's an incredibly inefficient way to use an incredibly valuable resource. What should the government do to allocate these permits? The government's got a bunch of permits. What should it do?

AUDIENCE: Sell to the highest bidder.

JON GRUBER: It should auction them. Think about the money the government could raise. So for example, another thing like this is the government owns the spectrum that all our cell phones and things go over. The government used to just give away that spectrum to cell phone companies. Now it auctions it, and the auction is designed by economists, another big victory for economists, and makes a lot of money every year from these auctions.

We should do the same thing with these permits. This is a valuable resource the government owns. The government is saying, we're regulating. You say it's a resource, government should auction it and take that money and use it to help people.

So the efficiency, some economists would say, is auction the permits. Take the money. Give it to poor people who face higher fuel prices. Remember the argument for free trade I talked about in 14.01. The idea is, one party loses, one party wins.

But the party that wins, wins by more. You take that extra and reduce reduce to the party that loses. Everybody can win.

There's a similar argument here. The problem is politically, the utility said, no, if you're going to do this, we want the permits. So the problem with how they were going to do that was how they were going to distribute them.

This legislation, despite these problems, actually passed the House of Representatives, but was killed in the Senate. It was just viewed as too difficult, raising the price of energy, too easy to kill this with talking points. So we tried taxing, didn't work. We tried regulating, didn't work.

So President Biden turned to a third approach. The third approach is, if you can't tax a bad thing, you sure can subsidize the good thing. And so the third approach, which was in the Inflation Reduction Act, was a massive set of subsidies for moving away from fossil fuels towards clean energy.

Subsidies came in multiple forms. First of all, there were subsidies for production and R&D on new types of new types of energy. There were subsidies for-- so one big spend was basically, like, billions of dollars to develop hydrogen alternatives, electric alternatives, billions of dollars for R&D into new energy alternatives. The second big expenditure was money to consumers to get them to switch to more energy-efficient alternatives so a $7,500 tax credit for buying an EV, money if you fitted your house to make it more fuel effective, et cetera. So it's basically a massive subsidy towards fuel efficiency.

Now, in a standard economic world, the subsidy is the opposite of a tax. Taxing the bad thing is the same thing as subsidizing the good thing. But it is not as good for two critical reasons.

The first critical reason is the car example I gave you a few minutes ago. We're giving people EVs, so they're going to ship their gas-guzzling cars to other countries. If there was a global tax on carbon, those other countries wouldn't use the cars either. That's the first problem.

The second problem is it costs money. With one, you raise money. With the other one, you spend money.

Now, you'll talk about chapter 4, not this week, but next week in section-- or I guess two weeks because next week is a holiday. And we used to care about deficits. We don't really anymore.

So the insight of Biden was, look, this is the right thing to do. There's no other way to do it. Nobody seems to care about deficits anymore. I'm going to spend $500 million-- it was actually $389 billion, moving us towards a clean economy.

It was the most significant piece of legislation in fighting global warming in our nation's history. And the question is, is this the sad lesson we've learned that, in fact, we have to do the wrong thing if we want to do the right thing? And that's something we'll just have to see over time.

Now, the last point is, where are we now in the world? Well, the most significant recent round was the Paris round of negotiations back in 2015. The Paris Agreement was an agreement, under President Obama, to significantly reduce emissions around the world.

The US signed it, but it's all voluntary. Nobody comes in and pounds me if you don't do it. It was a voluntary agreement. It was a very significant agreement signed by 186 countries, so it brought in developing countries. It set up a very significant set of goals.

So the US in particular, we pledged to reduce greenhouse gas emissions by about 26% below 2005 levels by the year 2020, or starting year 2020. It basically agreed to a very aggressive reduction without a plan for doing it. Just, we're going to do it. And other countries did too.

As soon as President Trump was elected, we withdrew from the Paris Agreement. And then when President Biden was elected, we got back into the Paris Agreement. And we'll see which-- you can predict what's going to happen with this election. And as a result, we haven't done a whole lot. I mean, the Inflation Reduction Act that I just described is the one most significant investment we've made.

You can contrast that actually with China. Now once again, China did not get special treatment under the Paris Agreement. I talked about trying to buy China a special agreement. They didn't actually get it. And yet, China has aggressively moved to regulate emissions.

They're going to have the largest emission trading scheme in the world. They've already started one that involves about three billion tons of CO2 annually. They're doing a set up an entire new climate monitoring system to make people aware of air quality and to fight it.

And basically, it is working. They're actually reducing their emissions relative to the rest of the world. So this can be done.

The answer is, maybe it's harder to do in a democracy than in some place that's not a democracy. But it can be done. And the good news is coming out of China, And once again, I don't want to poo-poo the Inflation Reduction Act too much. This was an important step. It was a major step towards fighting global warming. It's one that needed to be taken. It's just nice economist who could have done it the right way rather than the wrong way. Yeah.

AUDIENCE: [INAUDIBLE] the Europeans [INAUDIBLE].

JON GRUBER: I'm not sure what the Europeans are doing. I mean, the Europeans are in a tough spot because they've already gone pretty far. I mean, how many people have been to Europe and seen gas prices over there?

I mean, it's, like, twice what we are. They've already gone pretty far to be a low-carbon economy. So their reductions are even more expensive than ours are.

So I'm not quite sure where Europe is on this front. I think it varies a lot country by country. I'm not sure the EU has got a general policy or it's..

Each country was a signatory, not the EU as a whole. So I'm not sure what each country is doing. It's a good question. Other questions about this? Yeah, Enoch.

AUDIENCE: Subsidies are very expensive. Yeah we don't care about deficit. But if you look at the cost savings [? from ?] a healthier populace, does it impact [INAUDIBLE]?

JON GRUBER: Yeah, this is a great general question we'll ask a lot this semester. One could call it generally the offset question, which is to what extent can the fiscal benefits. We know we'll be healthier.

But that doesn't count for the government. Does being healthier have fiscal benefits for the government? We have to pay less to treat kidney disease. And to what extent does that offset the cost here?

So there's two answers to that. One is, those are harder to measure. And so there's a lot of uncertainty in measuring them. Get three answers. My wife says, I should never give a number before a list because I always add one.

Two is that the benefits are very long run and politics is very short run. So that's a challenge. The third thing which you'll learn-- I'm not going to spoil it, because it's one of the best parts of chapter 4. The way we do policy in the US says basically nothing matters after 10 years.

And you'll learn about why when you do chapter 4. And that makes it pretty hard to justify something which is going to have savings in more than 10 years and cost in the first 10 years. But it's absolutely right theoretically. Other questions? Yeah.

AUDIENCE: So like the first point-- the problem with subsidies was the same outsourcing issue. Is there a nuance between [INAUDIBLE] between subsidies and taxes.

JON GRUBER: No. Well, when it's US-specific, there wouldn't be a difference. The difference is a tax would be easier to coordinate worldwide than subsidies. A worldwide tax wouldn't have that problem. I was being a bit subtle on that. Good question. Yeah.

AUDIENCE: [INAUDIBLE] this is going back to cap and trade for power plants [? as ?] an example. But [INAUDIBLE]. How does it play out when you have a cap and trade scheme, but you have something like a power plant with a natural monopoly? The people supplied by the local power plant that's really, really dirty, does that market just get [? screwed ?] because they're going to have to pay a lot [INAUDIBLE] power plants?

JON GRUBER: Well, I mean, the main thing is-- that's a great point. And there's the general question of over what geographic area do you want to regulate? So in other words, do you want to say it has to be nationwide below this level and we're gonna do it equally, or we're going to allow for different areas? And once again, that's the point of a cap and trade system. So those people will be screwed potentially in terms of having to buy a lot of permits.

But once again, if they're selling to a national energy market, hopefully that will be mitigated. I mean, this is actually a big-- hopefully, the permit price will come down. But those people, if you live a power plant-- and that's why they allocate.

Unless you allocate more permits to them, then they won't be screwed. So that's why the ACES plan did it that way. If you give them more permits to start, they won't be as screwed.

AUDIENCE: I guess the question that I have is, does the cost get borne-- that increased cost of having to buy more permits? Ideally that would somehow get distributed throughout the market and everyone would have [INAUDIBLE] little bit [? more ?] expensive. But [INAUDIBLE] with an isolated power plant like that [? in ?] an isolated community, would it just be a lot more expensive there?

JON GRUBER: It wouldn't-- once again, if you did not distribute extra permits to them, then yes. You would have geographic disparities.

AUDIENCE: [INAUDIBLE] a question about [INAUDIBLE]. Was the US Senate blocking a [? lot ?] of these policies. What is the justification? Was it [? challenging, ?] like we saw China do it. I'm European, and so I don't fathom it. What is the justification [INAUDIBLE]?

JON GRUBER: Look, the Senate and the House are both bad guys in blocking stuff. But basically, it's just political calculus. And we'll talk about this in chapter 9. Like I said, it's unfortunate that politics underlies everything we do this semester, but only spend one lecture on it. But really, just the view in the Senate was that politicians felt they'd lose their jobs.

When I was on the flight to Kyoto, one of the most fun parts-- I spent about three hours chatting with a guy named Tom Foley. He was the former Speaker of the House. And it was a great conversation and I felt comfortable with him.

And I said, look, I loved what you did as a Democrat. I loved what you did, except I really was upset you weren't strong on gun control. I mean, gun control is the most important issues in this country, and you would always oppose it.

And he said, look, I'm from a district in rural eastern Washington. He said, my district cares about guns. It's one of the number one voting issues in my district.

He said, if I ran a company that did a bunch of good stuff and one bad thing, and fixing the bad thing would drive my company out of business, would you say I'm morally obligated to do that? And he said, I voted for gun control once in my life, and I lost my job. And I was replaced by a Republican who does a lot of bad things.

Politicians are always making this trade-off of the many things they could do. And some politicians who care about global warming may have decided, well, if I vote for this, I'll lose my job. And someone who doesn't care about anything will take it. So that's the positive spin.

The negative spin is they just want power and have these jobs. And they'll do anything to hold on to them. And we'll talk about that in chapter 9.

Other questions about that? This is a very important area. And it's very, very significant for your generation to be taking this on.

OK, let's start with the next section. We'll do about 10 minutes on the next section, which is health externalities. And let's start with probably the easiest health externality to think about-- I'll explain why next time, which is cigarette smoking.

Now, you guys don't think a lot about cigarette smoking because basically, not many folks in your social circle smoke. But there's actually still quite a lot of smokers in the US. So if you look at figure 6-4, almost half of all Americans smoked in 1955. Today, it's down. About 15% of Americans smoke now.

Now, 15% is still a lot. You might say, 15%, that's 1 in 6. You might look around and say, look, one in six people I know don't smoke. How come 15% of Americans smoke?

The answer is fascinating. One of the reasons it fell was education. We started learning that smoking is bad for you. My wife bought me great at a garage sale a sign from the 1940s of a doctor saying, smoke Chesterfields they're good for you. I mean, we started realizing in the 1950s, smoking was bad for you.

So before 1955, smoking rates were about 45% in the US. And they were everyone. 45% of everyone smoked. Starting in '55, smoking dropped, but mostly among the most educated because they were the ones that could effectively absorb and use the information.

So in fact, smoking rates against the most educated are down to close are very, very low. So that's the folks you hang out with. Smoking rates among less educated people are still much higher because of various things.

But one could be the information has just not been processed appropriately or fully. So that's why 15% may seem high to you, but it's a true national number. It's still a lot of smoking.

Smoking is a huge problem. Smoking causes 480,000 deaths each year. I'm sorry. Go ahead, question.

AUDIENCE: [INAUDIBLE] [? how ?] did they [? define ?] smoking?

JON GRUBER: This is smoked within the last month. Smoking causes 480,000 deaths each year. That's more than HIV, illegal drug use, alcohol use, motor vehicle injuries, and firearm-related incidents combined. More than 10 times as many US citizens have died prematurely from smoking than have died in all the wars fought by the US.

Worldwide, it's even worse. There are 1.3 billion smokers alive today, and half will die of smoking-related diseases. Over 8 million people die every year from smoking-related disease. And soon, it will be the leading cause of death in the world.

Now, that's bad. I think we can agree on that. Does that mean the government should be involved? And the answer is not necessarily.

Remember, smoking is a private decision where people weigh costs and benefits. And unless there are externalities, there is no argument for the government being involved. If I am someone who smokes and I sit on a rock in the middle of nowhere, and never get medical care and never talk to anybody and no one cares about me, then why shouldn't I get to decide how much I smoke? So the only real argument in traditional economics for regulating smoking is the externalities caused by smoking.

Now you might say, well, wait a second, Jon. Smoking is addictive. So isn't that a cause to regulate smoking?

And the answer is no. Why does the fact, absent externalities, why is even addictiveness not enough for the government to regulate smoking? Think like a Chicago economist based on an article written by the Nobel Prize-winning economist Gary Becker in 1988. Why?

AUDIENCE: [INAUDIBLE].

JON GRUBER: Yeah. So if you're rational, homo economicus, you say, well, look, smoking this cigarette is going to cost me whatever it costs-- $4 a pack. Plus, by smoking this, I understand I'm going to buy more packs in the future. So when I compute the cost, I compute the full cost to me, which is the effect on my health and the long-run cost to me of this additional cigarette. I understand that each additional cigarette, there's an extra marginal cost, which makes me smoke more in the future. As long as I understand that, no problemo.

So the fact that smoking is addictive-- this is very important. It's very important to understand the basic economic case. The fact that smoking is addictive is not per se a reason to regulate it above and beyond its externalities.

So the main reason a standard economic model to regulate smoking is externalities. So what are those externalities? Let's start talking about them.

If you look at table 6-1. Let's talk about externalities. Let's start with increased health care costs. By one estimate, cigarette-related disease increases US medical costs by $176 billion a year, about 8% of total medical spending. That's big. That's a lot of money.

So you might say, look, $176 billion, that's an externality. So cigarette taxes should be set to bear that externality. Why would that not necessarily be right?

I shouldn't have you look at the handout. Don't look at the handout. Why would that necessarily be right? Yeah.

AUDIENCE: [INAUDIBLE] [? if ?] the smokers [? are ?] the ones [INAUDIBLE] [? that ?] cost.

JON GRUBER: Yes, exactly. Remember, the externality definition has two parts. Your actions affect someone else and you don't bear the consequences. So imagine the way all health insurance worked is that everybody bought health insurance for themselves and the price included the damage done by smoking. In that world, there'd be no externality. Basically, I would internalize the externality because I would bear the extra cost my smoking does. Yeah.

AUDIENCE: [? In ?] that example, would there be an externality [INAUDIBLE] the insurance company [INAUDIBLE]?

JON GRUBER: No, there's no external insurance company. The insurance company says, look, I've computed for you at your age and your background, this is how much your smoking is going to cost us. Now, there's a subtlety. There's a little bit of externality because remember, we don't buy lifetime insurance.

The problem is, the externality might be on another insurer. So there is an externality. There is an externality insurer.

There's a clever point-- externality insurers, because the insurer you have today won't be the insurer when you're old. And then when you're old, it's going to bear the medical costs. So there's that externality.

But let's leave that aside. Let's imagine lifetime insurance, every individual buys on their own. It's in the premiums, no externalities. It's very important.

Reality, of course, deviates from that in a number of ways. The first way it deviates is people largely buy group insurance. So the cost of my health insurance is based on the health of the pool of MIT employees. An MIT employee smokes, my premiums go up because the cost of the pool of MIT.

Now that wouldn't be true if MIT could charge the smoker for insurance more. Before the Affordable Care Act, that was illegal. But the Affordable Care Act actually made it legal to base insurance premiums on smoking status. So that helps solve that problem.

But there's also the fact that many people don't buy their insurance. For example, if you're on public insurance, Medicare or Medicaid-- we'll talk a lot about those this semester, that's just paid for by the taxpayer by your past tax payments. You're not paying. There's no way to charge you more if you're a smoker. If you are uninsured, and you go to the hospital and get free care from the hospital, we're not going to charge you more if you're a smoker.

So there is an externality from smoking, from the medical costs of smoking. But remember, that externality only exists in the world where people don't internalize those costs. OK, I'm going to stop here. Thanks.