Lecture 07

Multiple Market Failures and Second-Best Policies

Ivan Rudik
AEM 4510

Roadmap

1. What happens when we have another distortion like market power?
2. How do second-best policies like output taxes or intensity standards work?

Market power and pollution

Market power

Lets consider two extreme cases to understand whether and how market power matters

1. Perfect competition
2. Monopoly

Market power

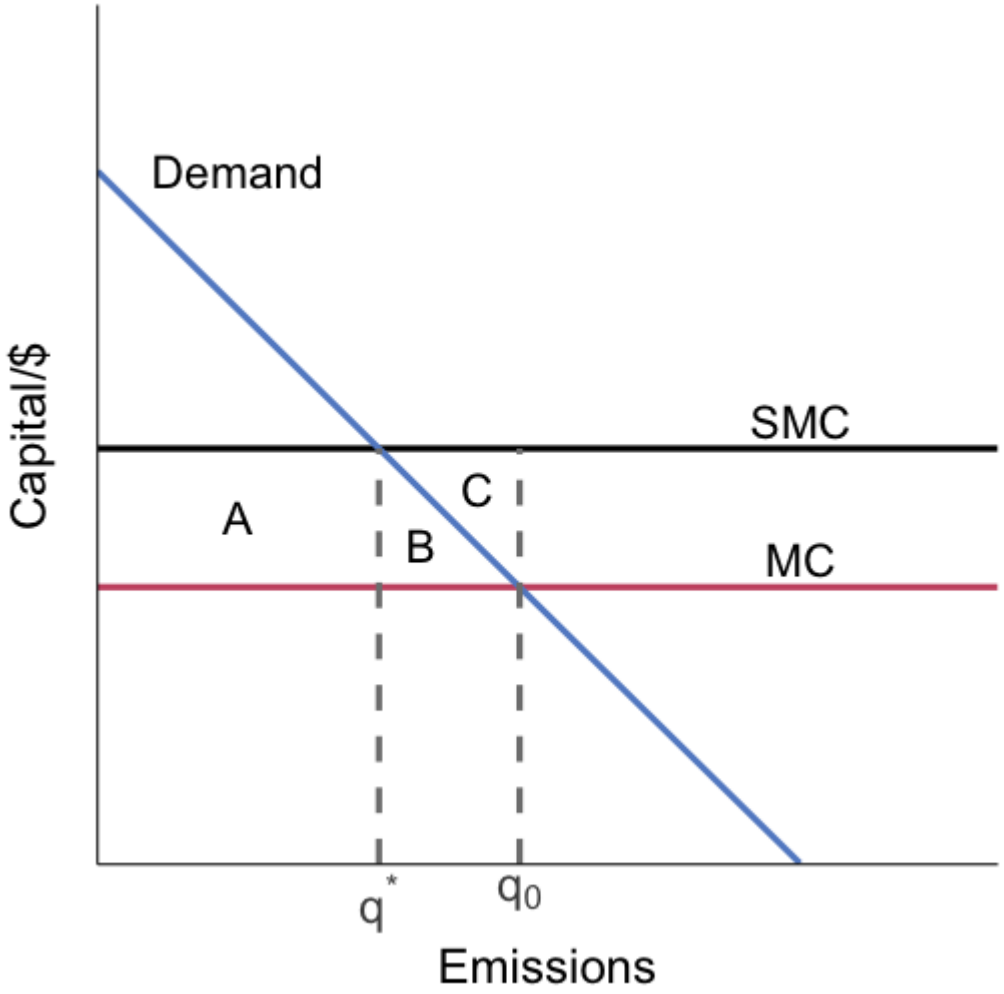
Lets consider two extreme cases to understand whether and how market power matters

1. Perfect competition
2. Monopoly

In both cases we will assume that:

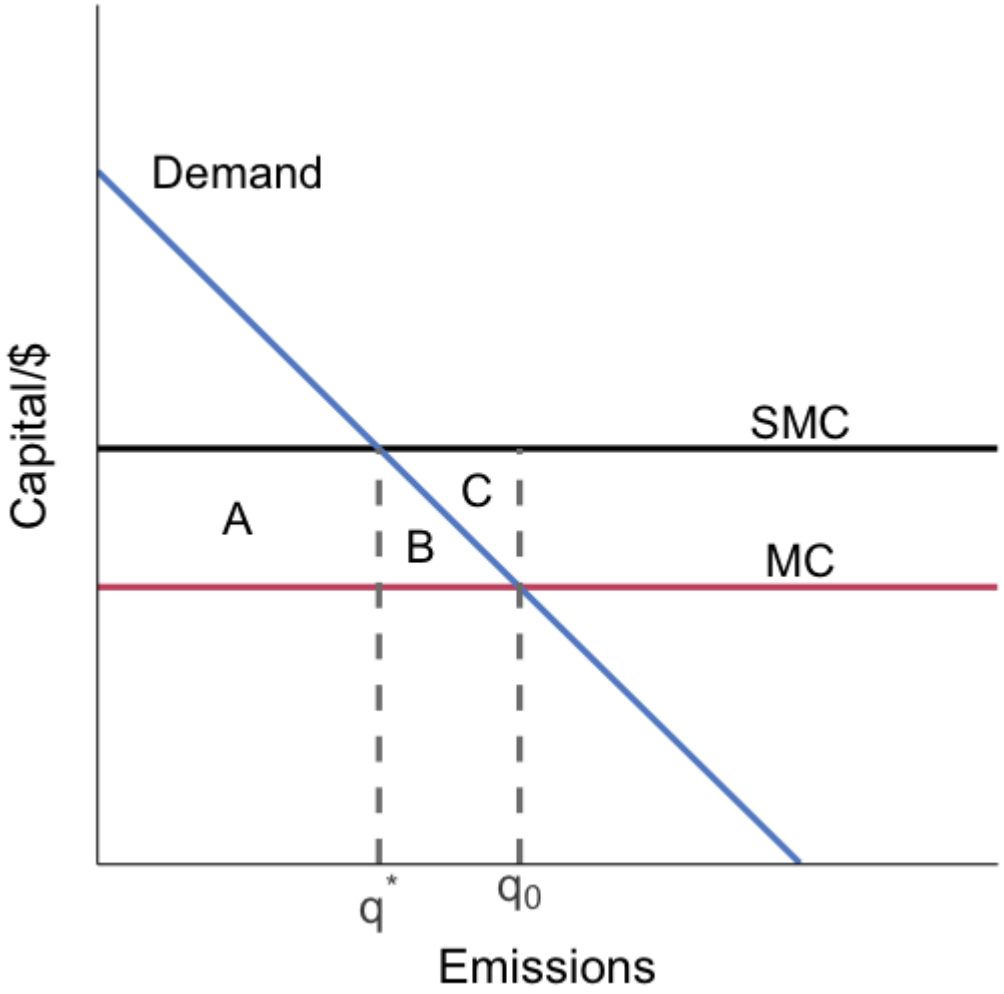
1. Marginal costs of production are constant MC
2. The marginal damage from a unit of output is constant giving us constant social marginal costs $SMC = MC + MD$

Perfect competition



The effect of moving from $q_0 \rightarrow q^*$ using a tax equal to marginal damage (SMC - MC):

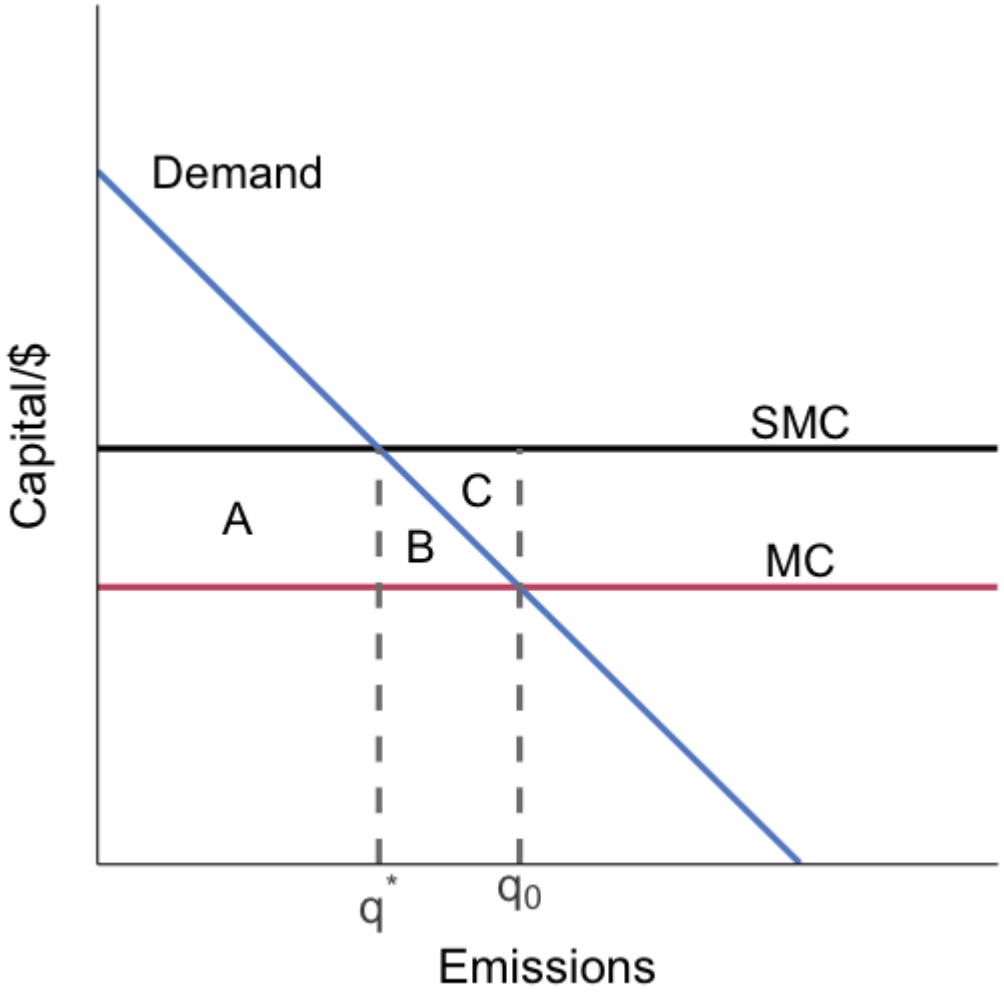
Perfect competition



The effect of moving from $q_0 \rightarrow q^*$ using a tax equal to marginal damage (SMC - MC):

Loss in CS: -(A+B)

Perfect competition

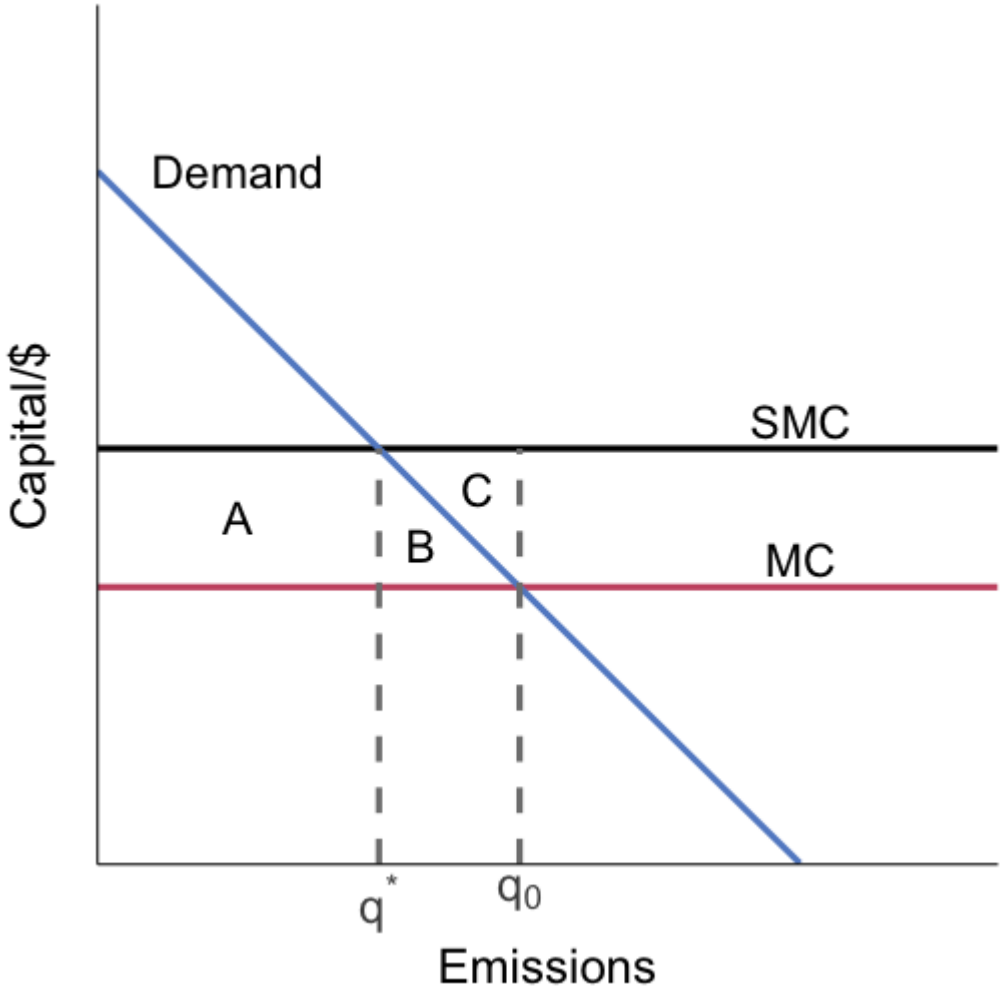


The effect of moving from $q_0 \rightarrow q^*$ using a tax equal to marginal damage (SMC - MC):

Loss in CS: -(A+B)

Avoided damages: B+C

Perfect competition



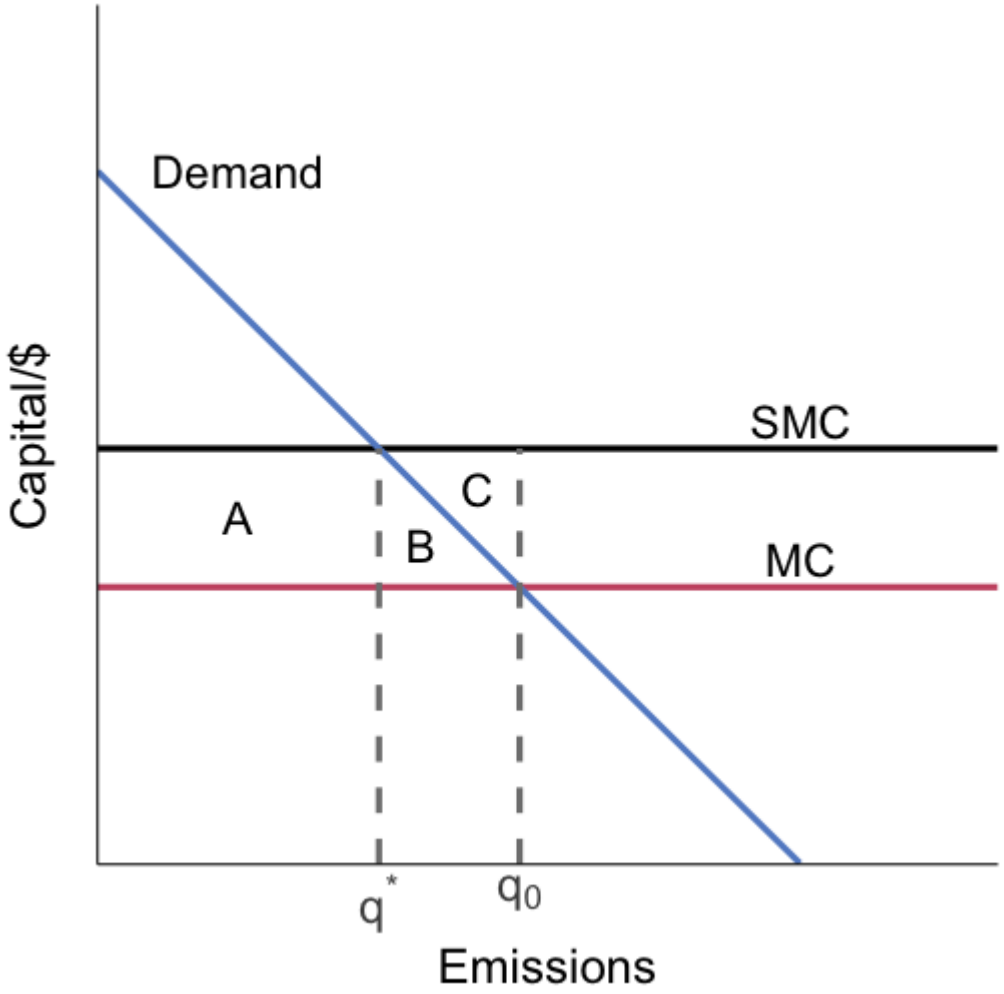
The effect of moving from $q_0 \rightarrow q^*$ using a tax equal to marginal damage (SMC - MC):

Loss in CS: -(A+B)

Avoided damages: B+C

Tax revenue: A

Perfect competition



The effect of moving from $q_0 \rightarrow q^*$ using a tax equal to marginal damage (SMC - MC):

Loss in CS: -(A+B)

Avoided damages: B+C

Tax revenue: A

Net gain: -(A+B) + (B+C) + A = C

Monopoly

Now consider a monopolist with the same marginal cost and marginal damage structure

Monopoly

Now consider a monopolist with the same marginal cost and marginal damage structure

What is the difference with a monopolist?

Monopoly

Now consider a monopolist with the same marginal cost and marginal damage structure

What is the difference with a monopolist?

The monopolist can set the price

Monopoly

Now consider a monopolist with the same marginal cost and marginal damage structure

What is the difference with a monopolist?

The monopolist can set the price

This means that the MR curve lies beneath the demand curve

Monopoly

Now consider a monopolist with the same marginal cost and marginal damage structure

What is the difference with a monopolist?

The monopolist can set the price

This means that the MR curve lies beneath the demand curve

Why?

Monopoly

Now consider a monopolist with the same marginal cost and marginal damage structure

What is the difference with a monopolist?

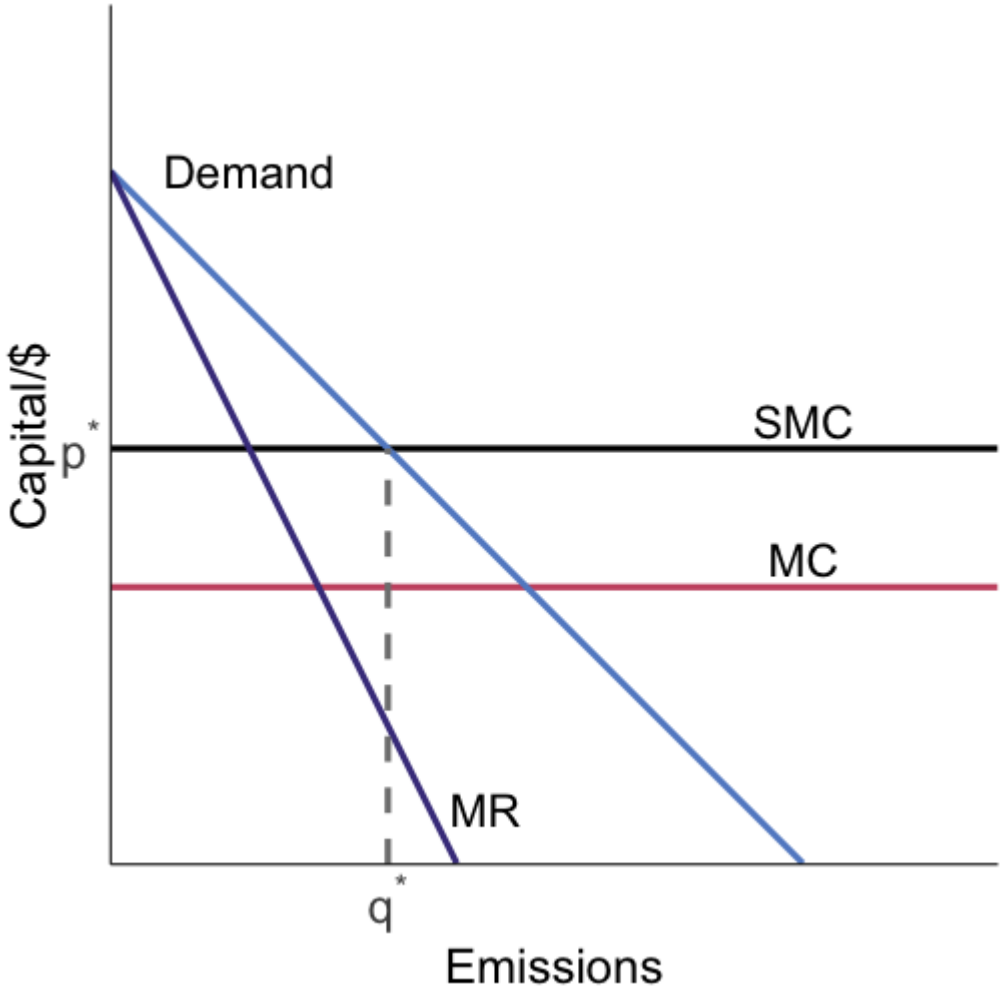
The monopolist can set the price

This means that the MR curve lies beneath the demand curve

Why?

The monopolist accounts for how additional output lowers the market price on inframarginal units

Monopoly

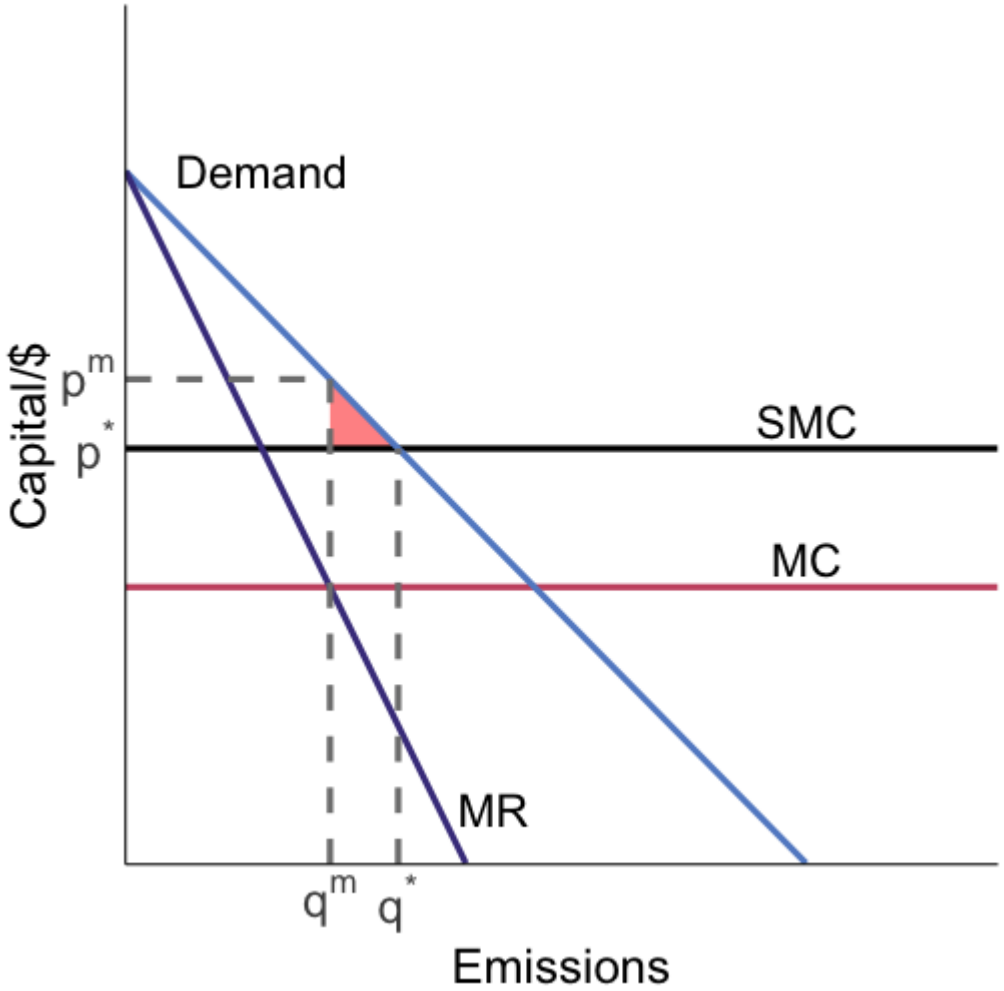


The socially efficient allocation is where social marginal cost is equal to the social marginal benefit

This is where SMC crosses the demand curve: (q^*, p^*)

What is the welfare outcome under the unregulated monopolist outcome?

Monopoly

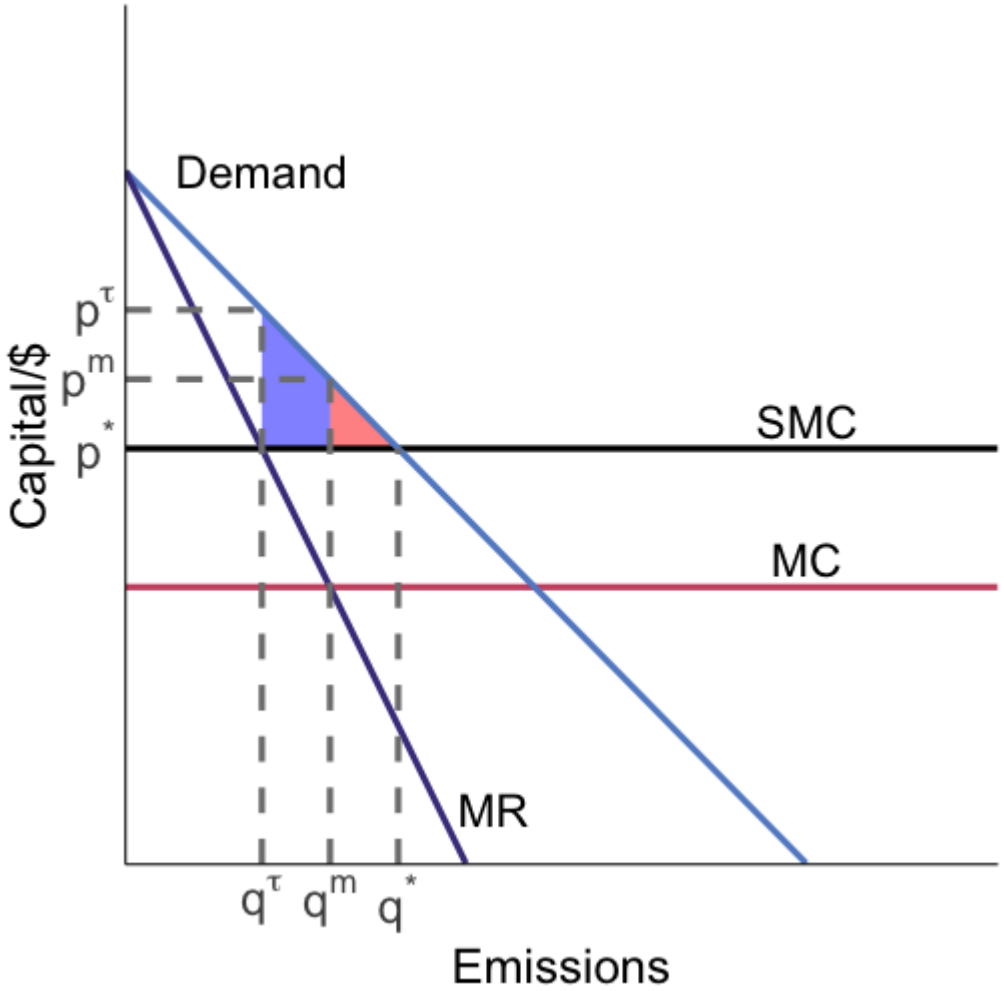


In the absence of regulation, the monopolist maximizes profit where MR = MC: (q^m, p^m)

This results in deadweight loss equal to the **red** area

Now what happens if we set a Pigouvian tax equal to marginal damage?

Monopoly

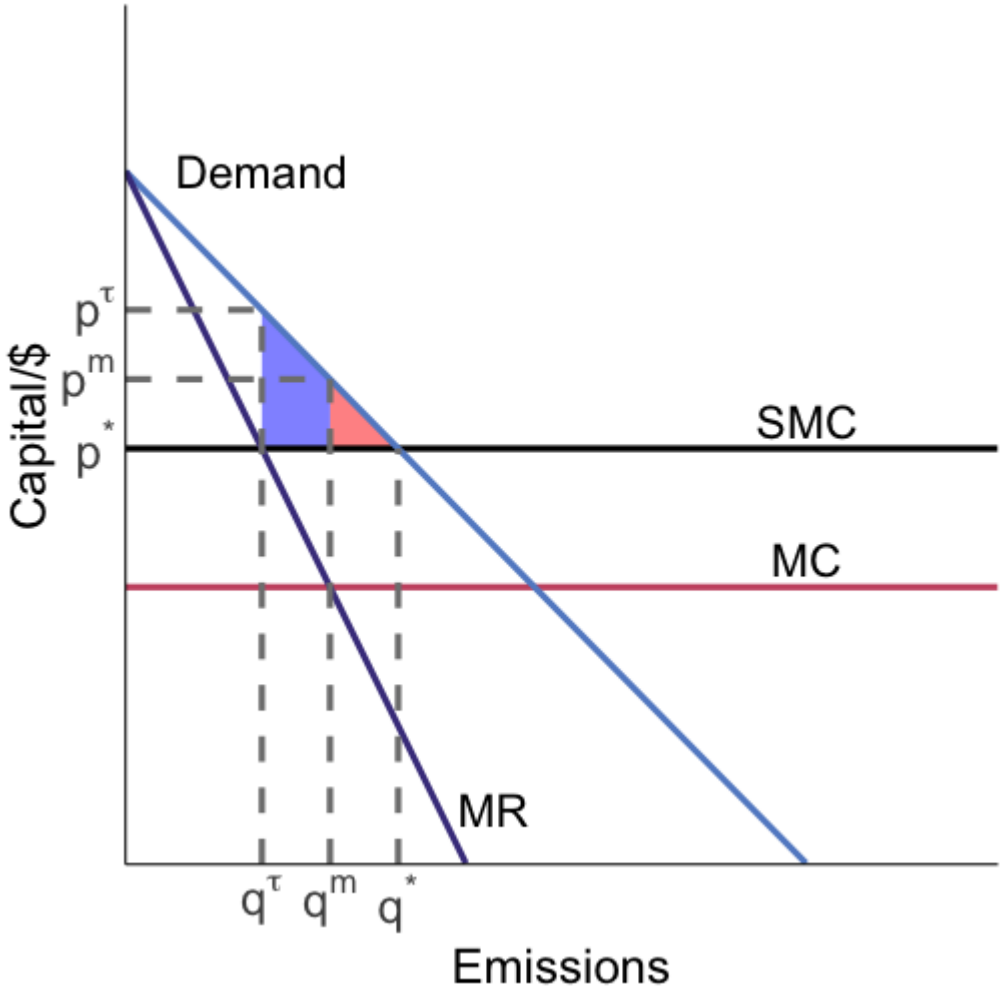


The Pigouvian tax restricts output even more, adding deadweight loss equal to the **blue** area on top of the deadweight loss in the **red** area

The tax actually made us worse off by the blue area!

Why?

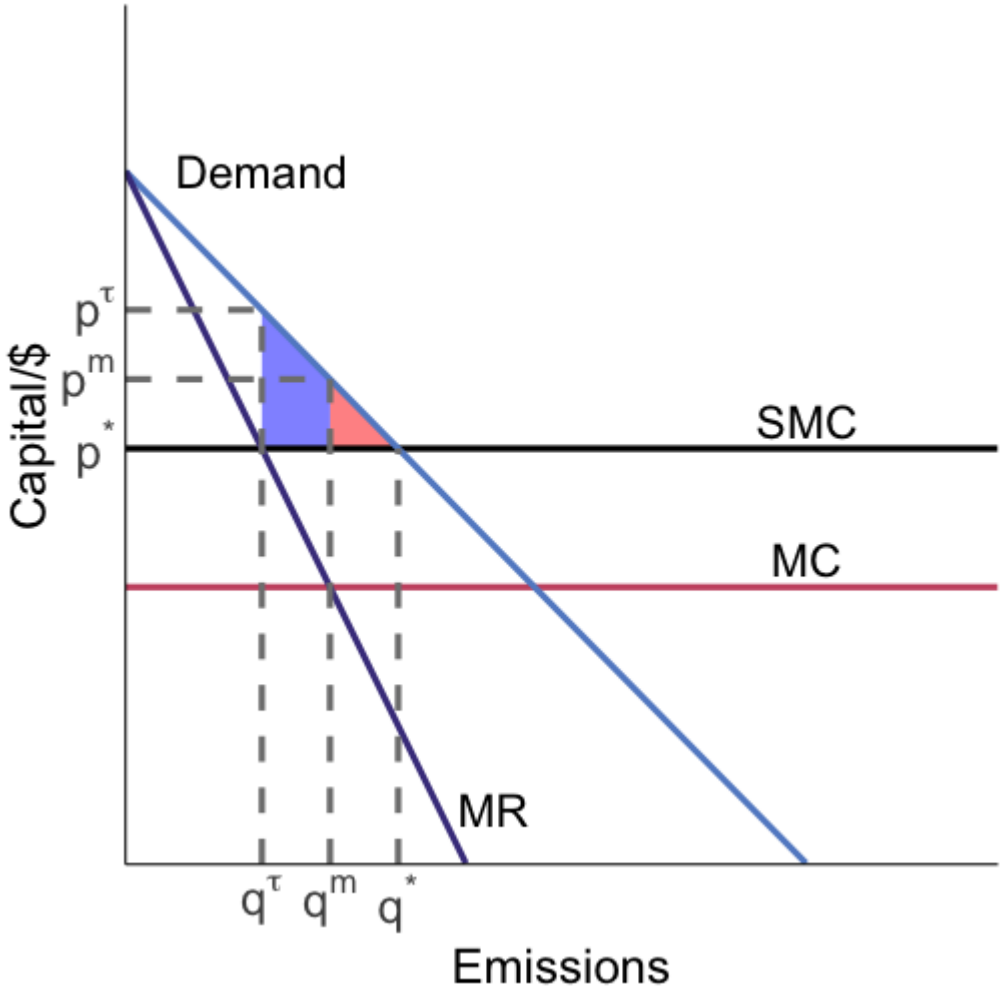
Monopoly



We now have two distortions:

1. Market power
2. Pollution externality

Monopoly

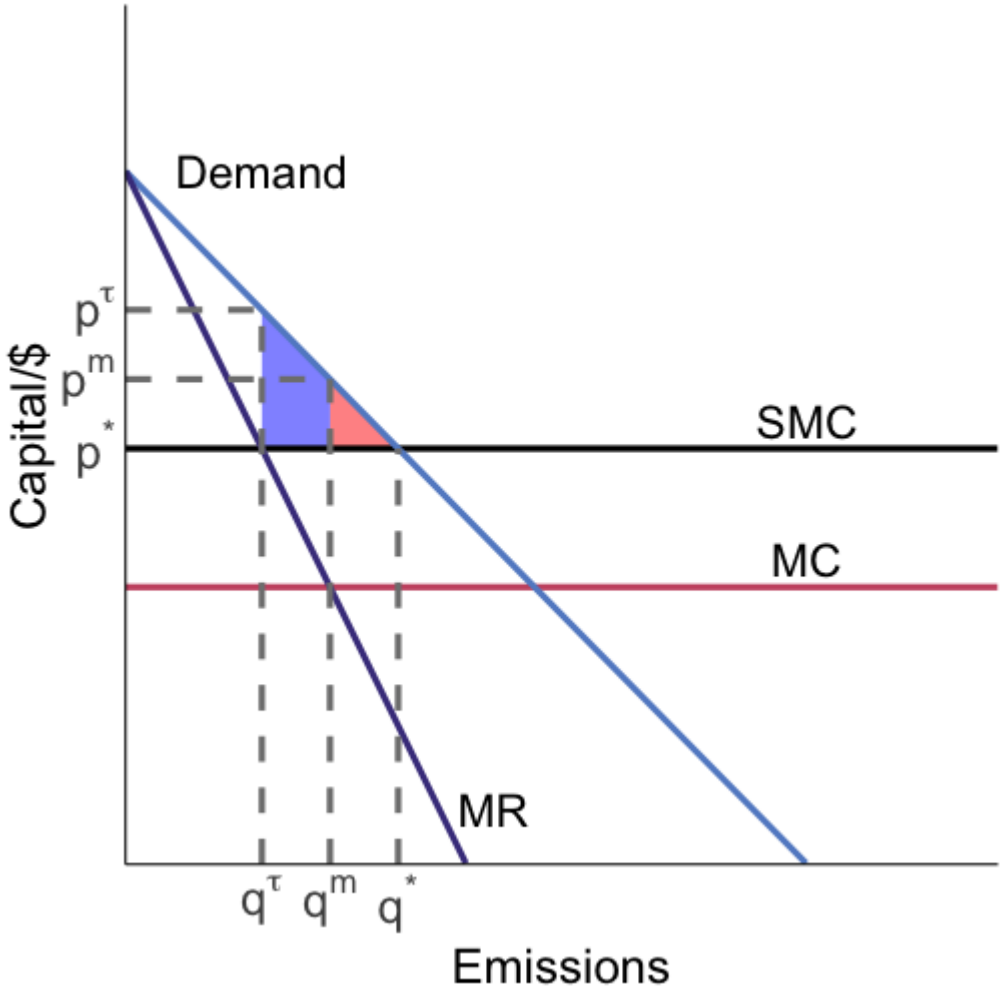


We now have two distortions:

1. Market power
2. Pollution externality

With market power, the unregulated equilibrium quantity is **too low**

Monopoly



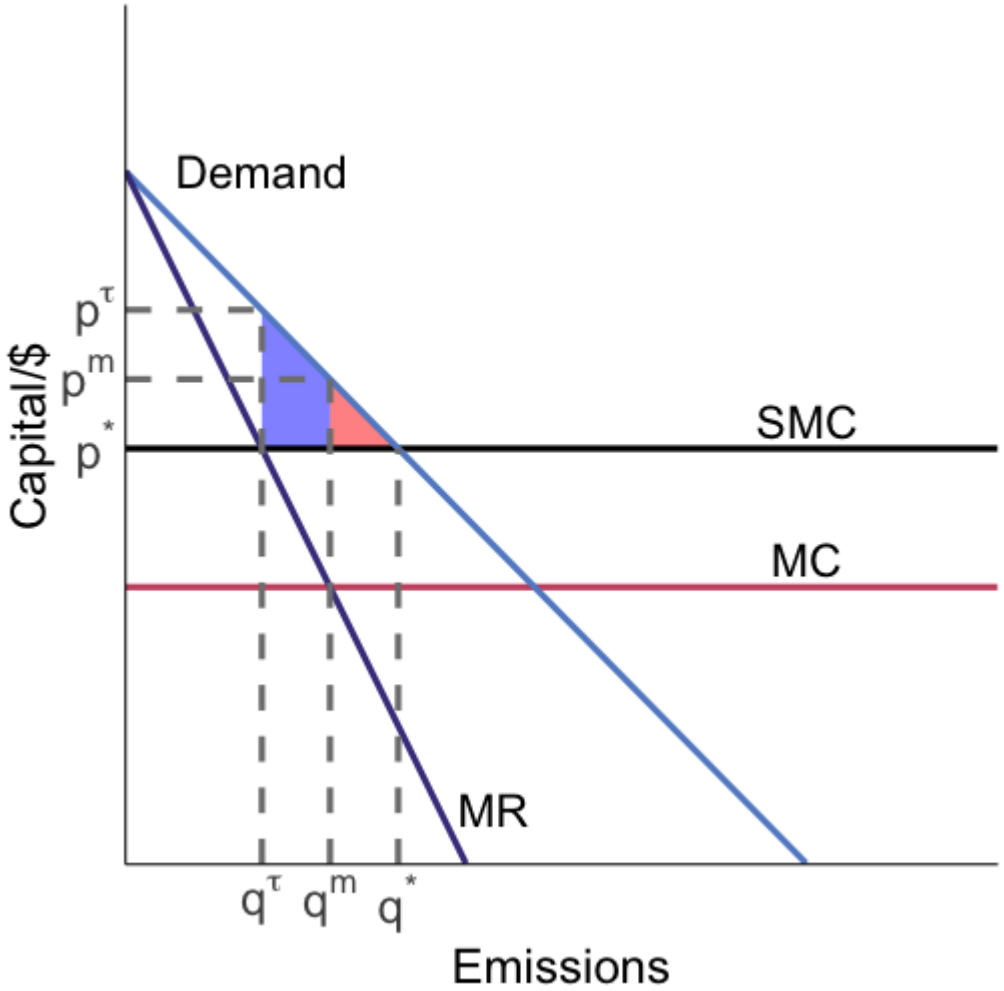
We now have two distortions:

1. Market power
2. Pollution externality

With market power, the unregulated equilibrium quantity is **too low**

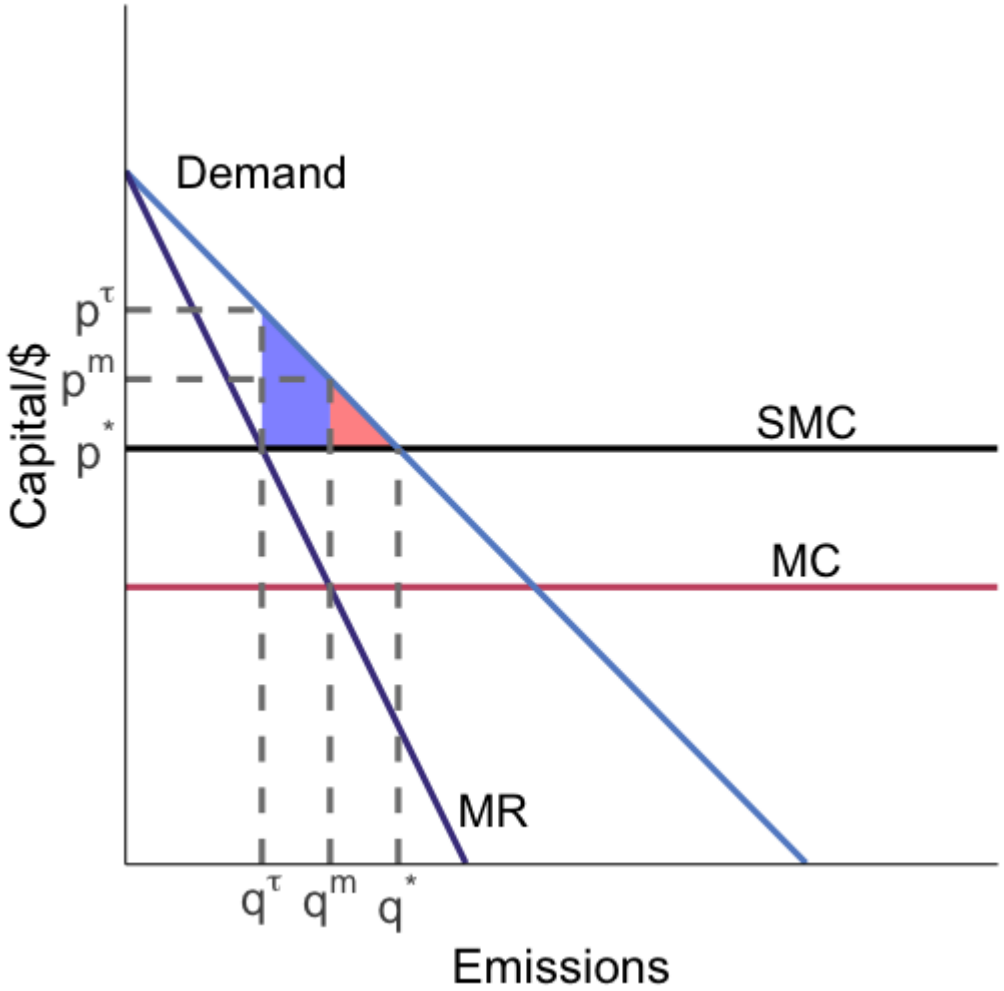
With a pollution externality, the unregulated equilibrium quantity is **too high**

Monopoly



They have opposing forces on quantities, so the market failures offset each other (partially)

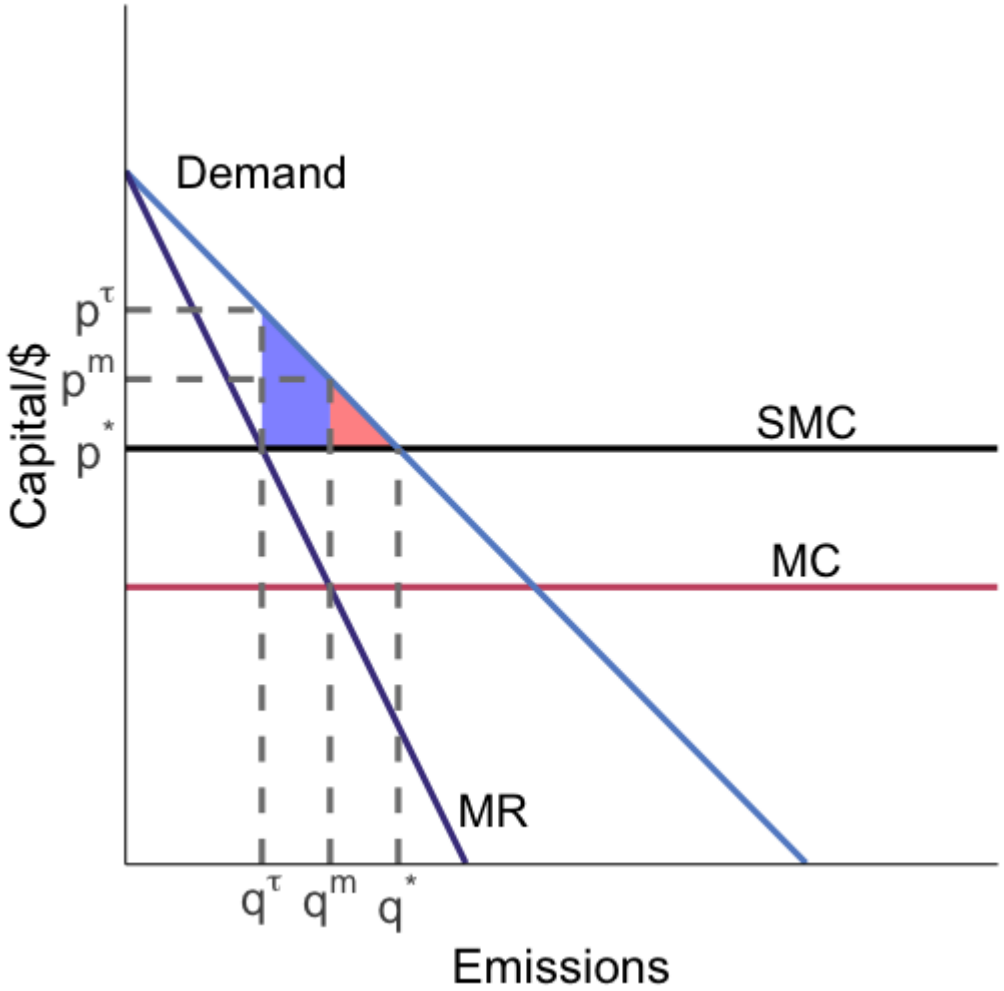
Monopoly



They have opposing forces on quantities, so the market failures offset each other (partially)

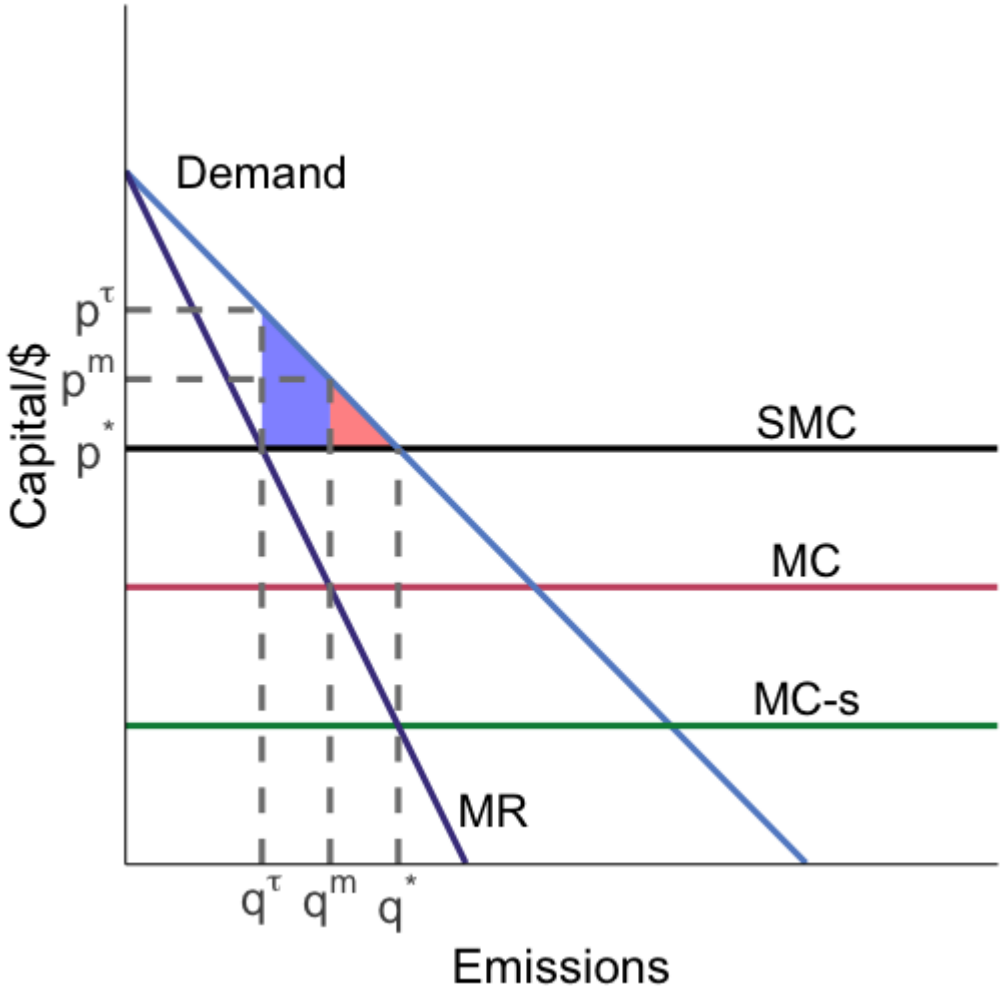
This means that if we fully correct the pollution externality, we no longer get the off-setting benefit and have the full welfare cost of market power

Monopoly



What is the actual optimal thing to do here?

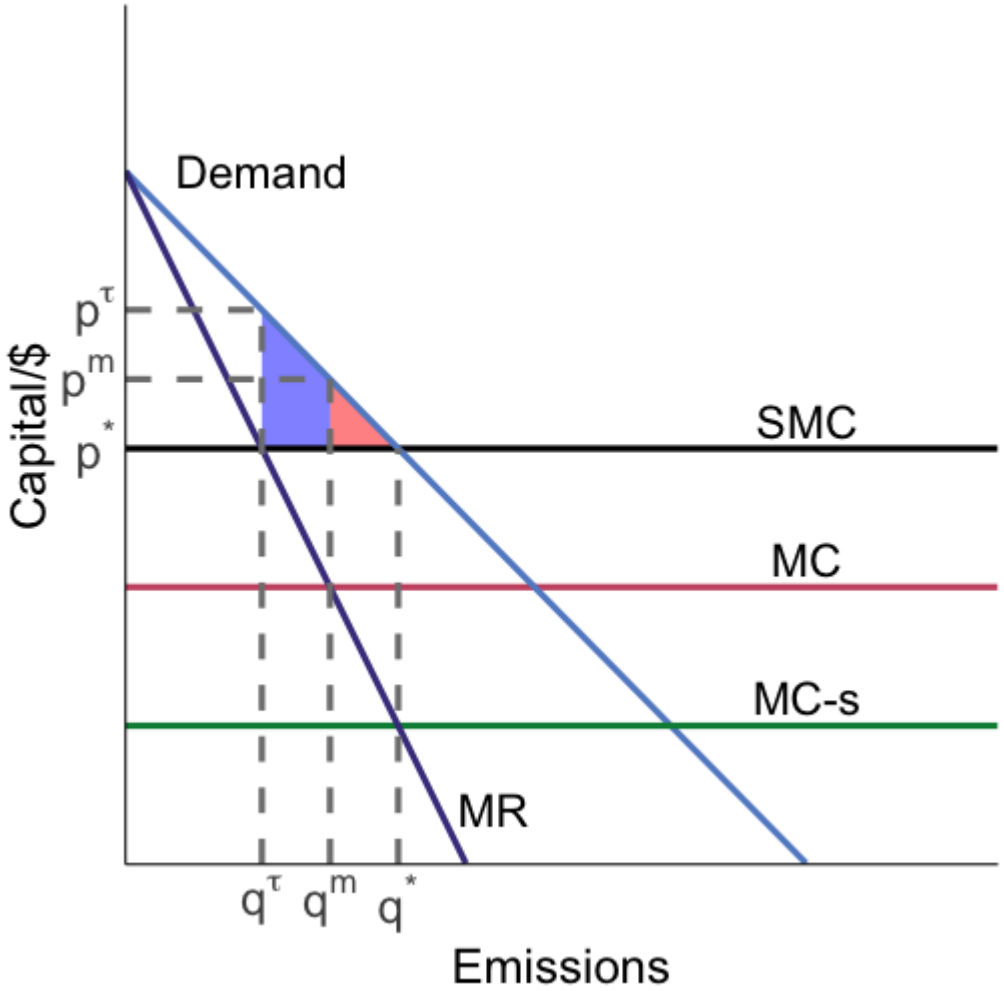
Monopoly



What is the actual optimal thing to do here?

subsidize output at rate s so $MC - s$ crosses MR at q^*

Monopoly



What is the actual optimal thing to do here?

subsidize output at rate s so $MC - s$ crosses MR at q^*

In this example, the market power externality dominates the pollution externality: we need to increase output

Monopoly

What did we learn?

Monopoly

What did we learn?

With multiple market failures we don't necessarily want to **fully** correct for a single market failure

Monopoly

What did we learn?

With multiple market failures we don't necessarily want to **fully** correct for a single market failure

In this example we actually wanted to do the **opposite** of what you likely thought

Monopoly

What did we learn?

With multiple market failures we don't necessarily want to **fully** correct for a single market failure

In this example we actually wanted to do the **opposite** of what you likely thought

You can always draw this example in a different way where you should tax output

Monopoly

What did we learn?

With multiple market failures we don't necessarily want to **fully** correct for a single market failure

In this example we actually wanted to do the **opposite** of what you likely thought

You can always draw this example in a different way where you should tax output

You just need marginal damages to be sufficiently large relative to the market power effect on quantity

Monopoly: more generally

So this was a **special case**: we assumed the marginal damage from production was constant

Monopoly: more generally

So this was a **special case**: we assumed the marginal damage from production was constant

If we generalize this so that the emission and output decisions are separate, we still have the two opposing market failures[1]

[1] The key thing here is that emissions are no longer a single function of output like $E = f(q)$. This means we can no longer write MD as a function of output q.

Monopoly: more generally

So this was a **special case**: we assumed the marginal damage from production was constant

If we generalize this so that the emission and output decisions are separate, we still have the two opposing market failures[1]

What changes is we can no longer fix them both with just a pollution tax/subsidy

[1] The key thing here is that emissions are no longer a single function of output like $E = f(q)$. This means we can no longer write MD as a function of output q.

Monopoly: more generally

Typically we must follow the **Tinbergen rule:** you need as many policy instruments as you have market failures to achieve the efficient outcome

Monopoly: more generally

Typically we must follow the **Tinbergen rule:** you need as many policy instruments as you have market failures to achieve the efficient outcome

What does that mean here?

Monopoly: more generally

Typically we must follow the **Tinbergen rule:** you need as many policy instruments as you have market failures to achieve the efficient outcome

What does that mean here?

We need:

1. Pollution tax

Monopoly: more generally

Typically we must follow the **Tinbergen rule:** you need as many policy instruments as you have market failures to achieve the efficient outcome

What does that mean here?

We need:

1. Pollution tax
2. Output subsidy

The tax incentivizes abatement, the subsidy incentivizes production

Output taxes

Sometimes emission taxes and abatement subsidies are difficult to administer because monitoring is hard

Output taxes

Sometimes emission taxes and abatement subsidies are difficult to administer because monitoring is hard

What can we do instead?

Output taxes

Sometimes emission taxes and abatement subsidies are difficult to administer because monitoring is hard

What can we do instead?

We can tax the output of the production process

Output taxes

Sometimes emission taxes and abatement subsidies are difficult to administer because monitoring is hard

What can we do instead?

We can tax the output of the production process

e.g. tax on electricity, cement

Output taxes

Sometimes emission taxes and abatement subsidies are difficult to administer because monitoring is hard

What can we do instead?

We can tax the output of the production process

e.g. tax on electricity, cement

Will this be efficient?

Output taxes

Sometimes emission taxes and abatement subsidies are difficult to administer because monitoring is hard

What can we do instead?

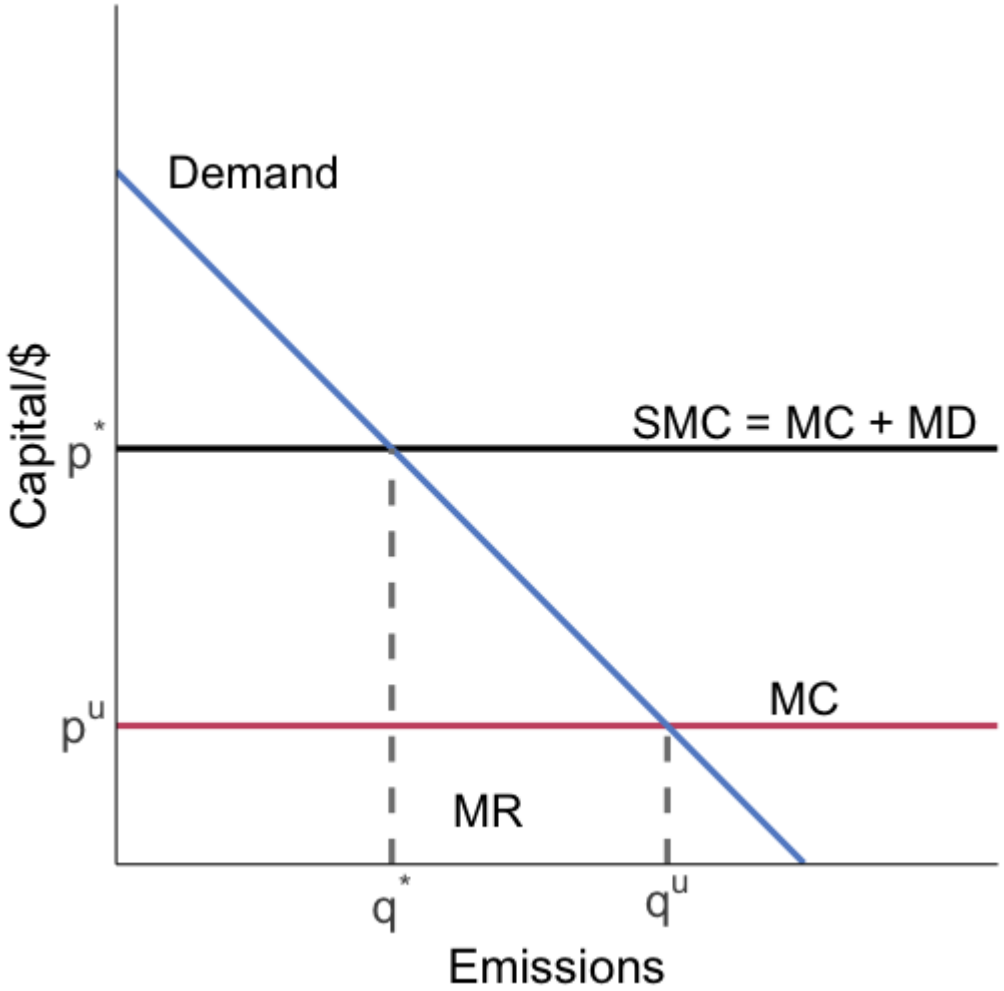
We can tax the output of the production process

e.g. tax on electricity, cement

Will this be efficient?

If so, what assumptions do we need about the production process?

Output taxes



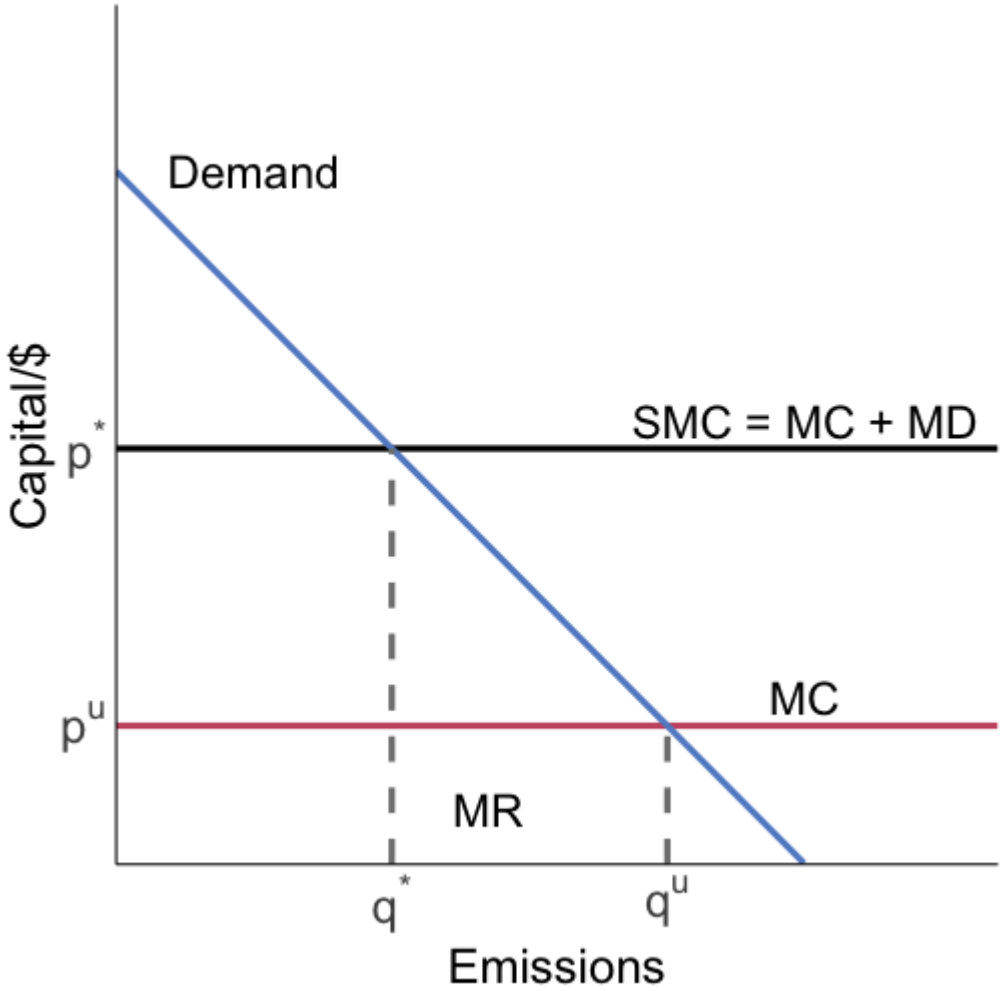
Assume emissions are proportional to output

And MD is constant

The firm chooses to produce/emit at q^u in the unregulated equilibrium

If we tax output equal to MD we can achieve the socially optimal allocation q^*

Output taxes



An output tax can be efficient, **if we assume that emissions are proportional to output**

Now let's break the link between output and emissions by writing down a slightly more complicated model where the firm chooses emissions and output separately

Output taxes, part two

Here's our model:

- Cobb-Douglas production using labor and emissions as inputs: $Q = L^{\alpha} E^{1-\alpha}$
- The firm pays wages w to labor, rental rate r to emissions (capital)
- The firm receives a price p per unit of output
- Emissions cause marginal damage d

Output taxes, part two

Here's our model:

- Cobb-Douglas production using labor and emissions as inputs: $Q = L^{\alpha} E^{1-\alpha}$
- The firm pays wages w to labor, rental rate r to emissions (capital)
- The firm receives a price p per unit of output
- Emissions cause marginal damage d

The firm can increase output without more emissions by increasing L

Output taxes, part two

Here's our model:

- Cobb-Douglas production using labor and emissions as inputs: $Q = L^{\alpha} E^{1-\alpha}$
- The firm pays wages w to labor, rental rate r to emissions (capital)
- The firm receives a price p per unit of output
- Emissions cause marginal damage d

The firm can increase output without more emissions by increasing L

What does an output tax τ_o do versus a regular emission tax τ_e?

Output taxes, part two

The regulator wants the firm to internalize its social costs:

$$\max_{L,E} p\, L^{\alpha} E^{1-\alpha} - wL - rE - dE$$

Output taxes, part two

The regulator wants the firm to internalize its social costs:

$$\max_{L,E} p\, L^{\alpha} E^{1-\alpha} - wL - rE - dE$$

The first-order conditions for a socially efficient allocation of L and E are:

$$\underbrace{\alpha p L^{\alpha-1} E^{1-\alpha}}_{\text{MR}} = \underbrace{w}_{\text{MC}} \qquad \underbrace{(1-\alpha) p L^{\alpha} E^{-\alpha}}_{\text{MR}} = \underbrace{r+d}_{\text{MC}}$$

Output taxes, part two

The regulator wants the firm to internalize its social costs:

$$\max_{L,E} p\, L^{\alpha} E^{1-\alpha} - wL - rE - dE$$

The first-order conditions for a socially efficient allocation of L and E are:

$$\underbrace{\alpha p L^{\alpha-1} E^{1-\alpha}}_{\text{MR}} = \underbrace{w}_{\text{MC}} \qquad \underbrace{(1-\alpha) p L^{\alpha} E^{-\alpha}}_{\text{MR}} = \underbrace{r+d}_{\text{MC}}$$

The for a social optimum we want to equate the MR (left hand side) with the SMC (right hand side) for both inputs

Output taxes, part two

The firm's problem for the output tax is:

$$\max_{L,E}(p-\tau_o)L^{\alpha}E^{1-\alpha}-wL-rE$$

Output taxes, part two

The firm's problem for the output tax is:

$$\max_{L,E}(p-\tau_o)L^{\alpha}E^{1-\alpha}-wL-rE$$

The firm's profit-maximizing choices are given by the first-order conditions:

$$\alpha(p-\tau_o)L^{\alpha-1}E^{1-\alpha}=w \qquad (1-\alpha)(p-\tau_o)L^{\alpha}E^{-\alpha}=r$$

Output taxes, part two

The firm's problem for the output tax is:

$$\max_{L,E}(p-\tau_o)L^{\alpha}E^{1-\alpha}-wL-rE$$

The firm's profit-maximizing choices are given by the first-order conditions:

$$\alpha(p-\tau_o)L^{\alpha-1}E^{1-\alpha}=w \qquad (1-\alpha)(p-\tau_o)L^{\alpha}E^{-\alpha}=r$$

The firm equates the MR and MC of each input

Output taxes, part two

The firm's problem for the output tax is:

$$\max_{L,E}(p-\tau_o)L^{\alpha}E^{1-\alpha}-wL-rE$$

The firm's profit-maximizing choices are given by the first-order conditions:

$$\alpha(p-\tau_o)L^{\alpha-1}E^{1-\alpha}=w \qquad (1-\alpha)(p-\tau_o)L^{\alpha}E^{-\alpha}=r$$

The firm equates the MR and MC of each input

The output tax penalizes the use of clean labor (despite it not causing any externalities) at a marginal rate of: $\tau_o L^{\alpha-1}E^{1-\alpha}$, this is **not efficient**

Output taxes, part two

How does this compare to a pure emission tax?

Output taxes, part two

How does this compare to a pure emission tax?

The firm's problem when facing an emission tax is:

$$\max_{L,E} pL^{\alpha}E^{1-\alpha} - wL - (r + \tau_e)E$$

Output taxes, part two

How does this compare to a pure emission tax?

The firm's problem when facing an emission tax is:

$$\max_{L,E} pL^{\alpha}E^{1-\alpha} - wL - (r + \tau_e)E$$

The firm's profit-maximizing choices are given by the first-order conditions:

$$\alpha(p)L^{\alpha-1}E^{1-\alpha} = w \qquad (1-\alpha)pL^{\alpha}E^{-\alpha} = r + \tau_e$$

Output taxes, part two

How does this compare to a pure emission tax?

The firm's problem when facing an emission tax is:

$$\max_{L,E} pL^{\alpha}E^{1-\alpha} - wL - (r + \tau_e)E$$

The firm's profit-maximizing choices are given by the first-order conditions:

$$\alpha(p)L^{\alpha-1}E^{1-\alpha} = w \qquad (1-\alpha)pL^{\alpha}E^{-\alpha} = r + \tau_e$$

A tax of $\tau_e = d$ can achieve the efficient allocation!

Output taxes takeaways

If emissions are perfectly determined by output, we can use output taxes to achieve the efficient outcome

Output taxes takeaways

If emissions are perfectly determined by output, we can use output taxes to achieve the efficient outcome

If emissions can be chosen separately from outcome by the firm, this is no longer true

Output taxes takeaways

If emissions are perfectly determined by output, we can use output taxes to achieve the efficient outcome

If emissions can be chosen separately from outcome by the firm, this is no longer true

In this case an output tax incorrectly taxes our clean inputs