Lecture 4

Imperfect information

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AEM 6510

Roadmap

What happens when the regulator has imperfect information about:

- Marginal abatement costs?
- Marginal damages?

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We will continue assuming that:

- Firms know their own marginal abatement cost
- Regulators observe firm-level emissions

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Estimation will naturally result in some error

Does this error matter for policy design?

Price vs quantities (Weitzman 1974)

Let's start by comparing emissions taxes and tradable permits

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We'll start by looking at damage function uncertainty with known abatement costs

Then we look at abatement cost uncertainty with known damage functions

We will mainly be focused on efficiency outcomes and want to understand which policy delivers the highest welfare and why

Damage function uncertainty

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- Let $\tilde{D}(E)$ and $\tilde{C}(E)$ denote the estimated damage and abatement cost function

First suppose the regulator estimates $-C'(E)$ correctly, but underestimates marginal damages: $\tilde{D}'(E) < D'(E)\ \forall E$

Damage function uncertainty

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What is the welfare loss from targeting $\tilde{E}$ instead of E^*?

Does the size of the loss depend on the policy instrument?

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$$\begin{aligned} WL &= [D(\tilde{E}) + C(\tilde{E})] - [D(E^*) + C(E^*)] \\ &= [D(\tilde{E}) - D(E^*)] + [C(\tilde{E}) - C(E^*)] \end{aligned}$$

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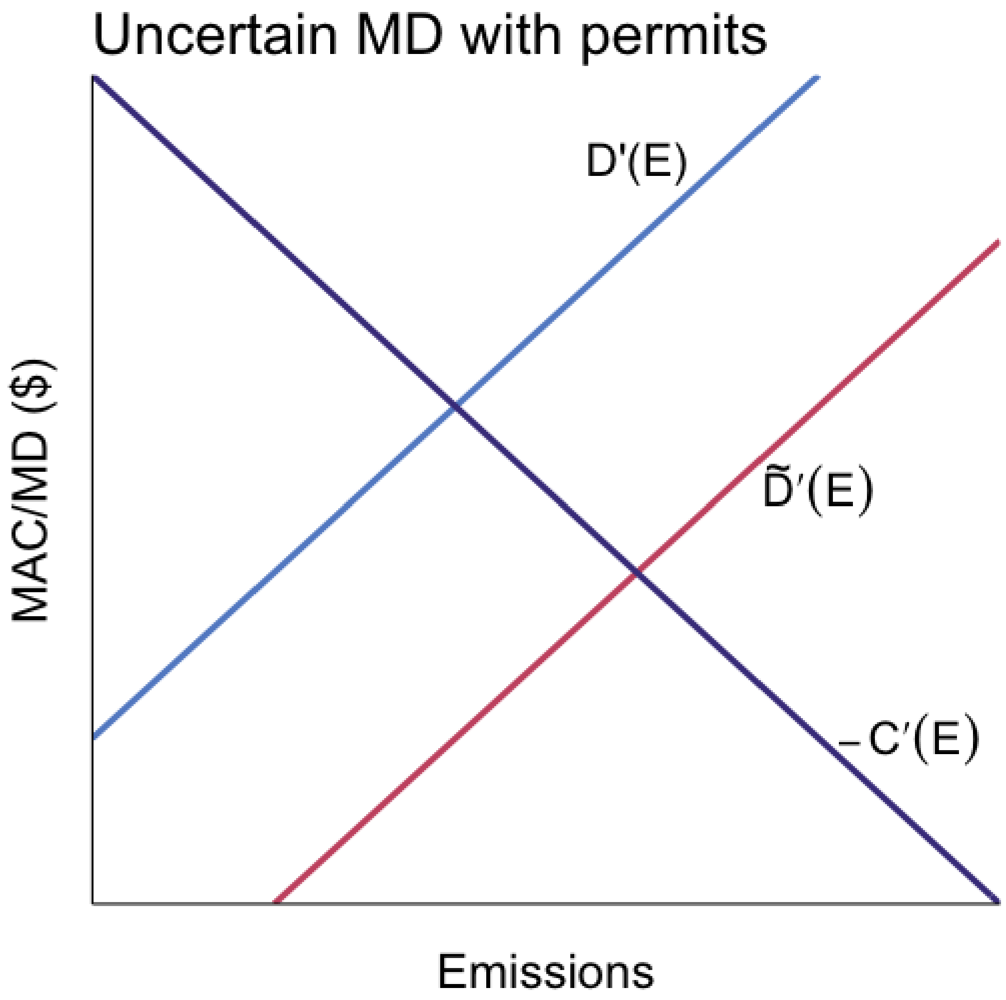
This is equivalent to the area under the marginal damage and abatement cost curves between the two emission levels:

$$WL = \int_{E^*}^{\tilde{E}} D'(E)dE - \int_{E^*}^{\tilde{E}} -C'(E)dE$$

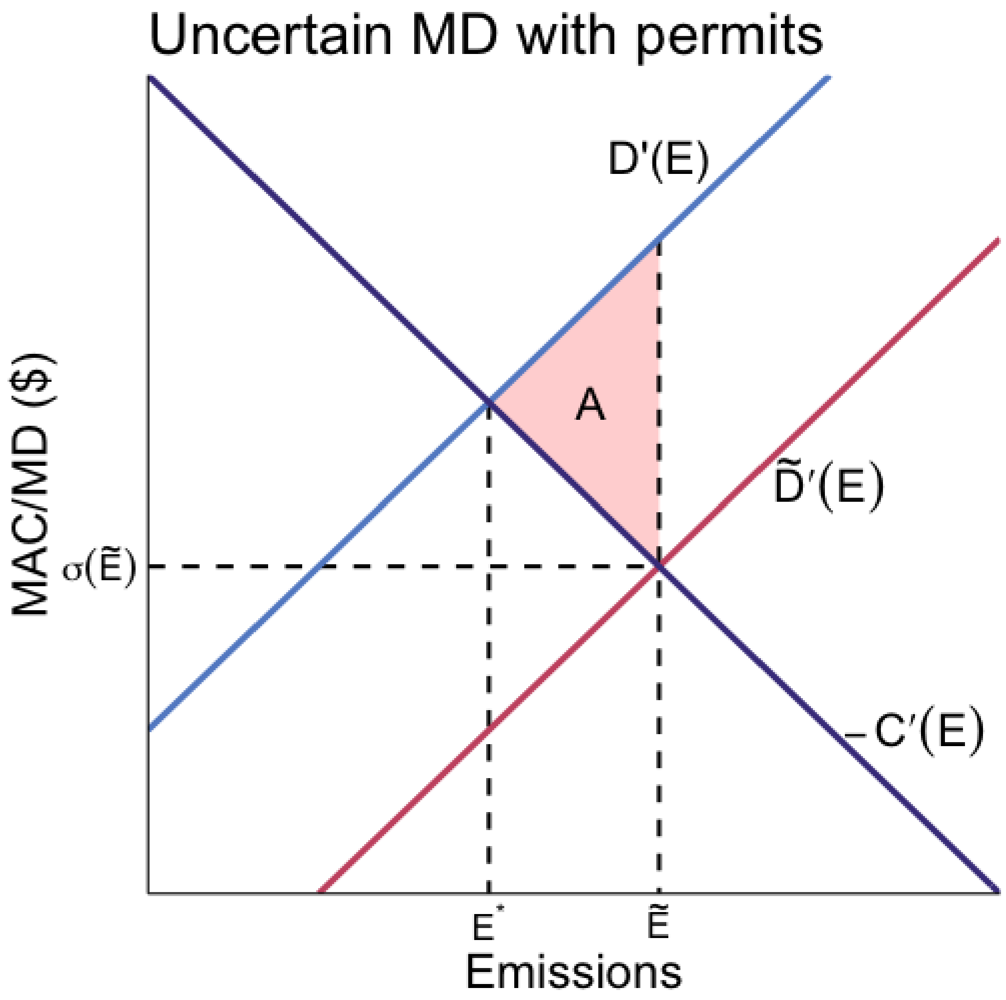
Damage function uncertainty with permits



Here is the set up

Solve for $\tilde{E}, E^*$ and the welfare loss from setting the number of permits to be $L = \tilde{E}$

Damage function uncertainty with permits

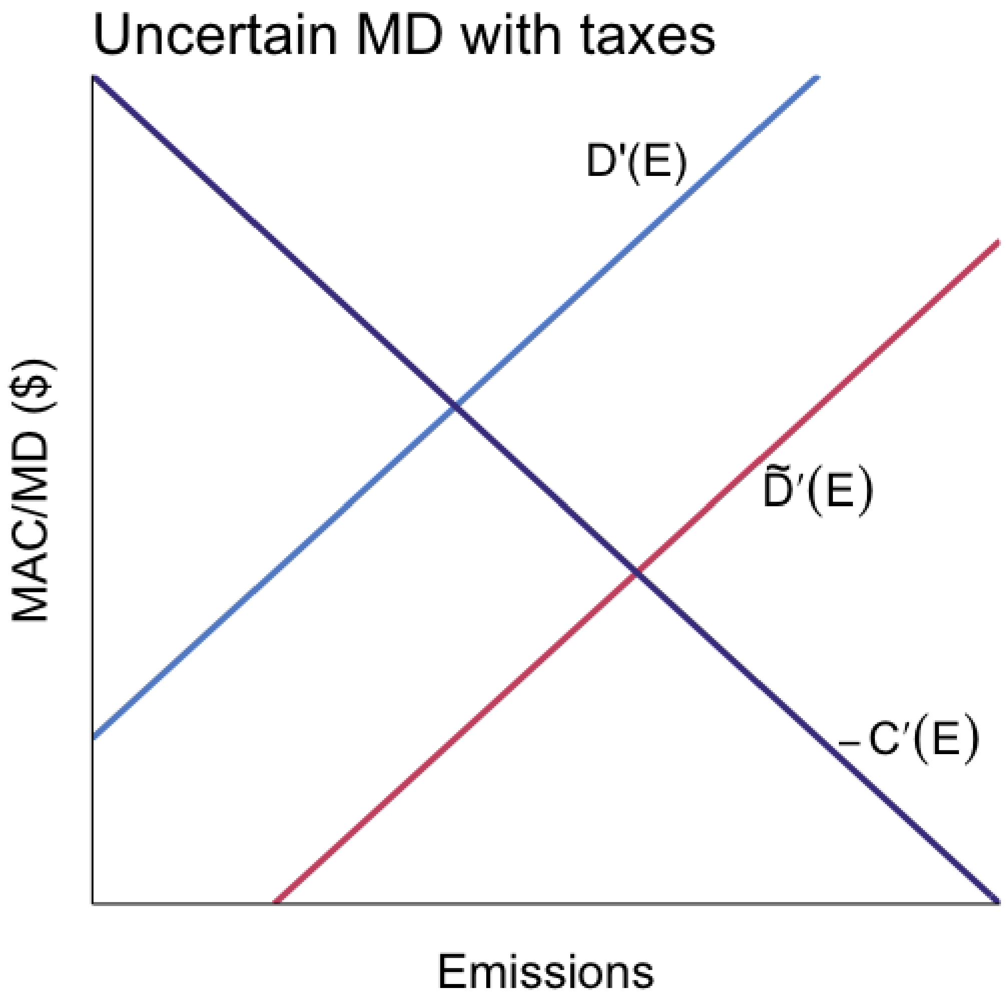


With a permit scheme the regulator fixes the total amount of emissions at $\tilde{E}$

Since she underestimates D', she lets firms emit too much

She incurs welfare loss A from emissions where marginal damage $>$ marginal abatement cost

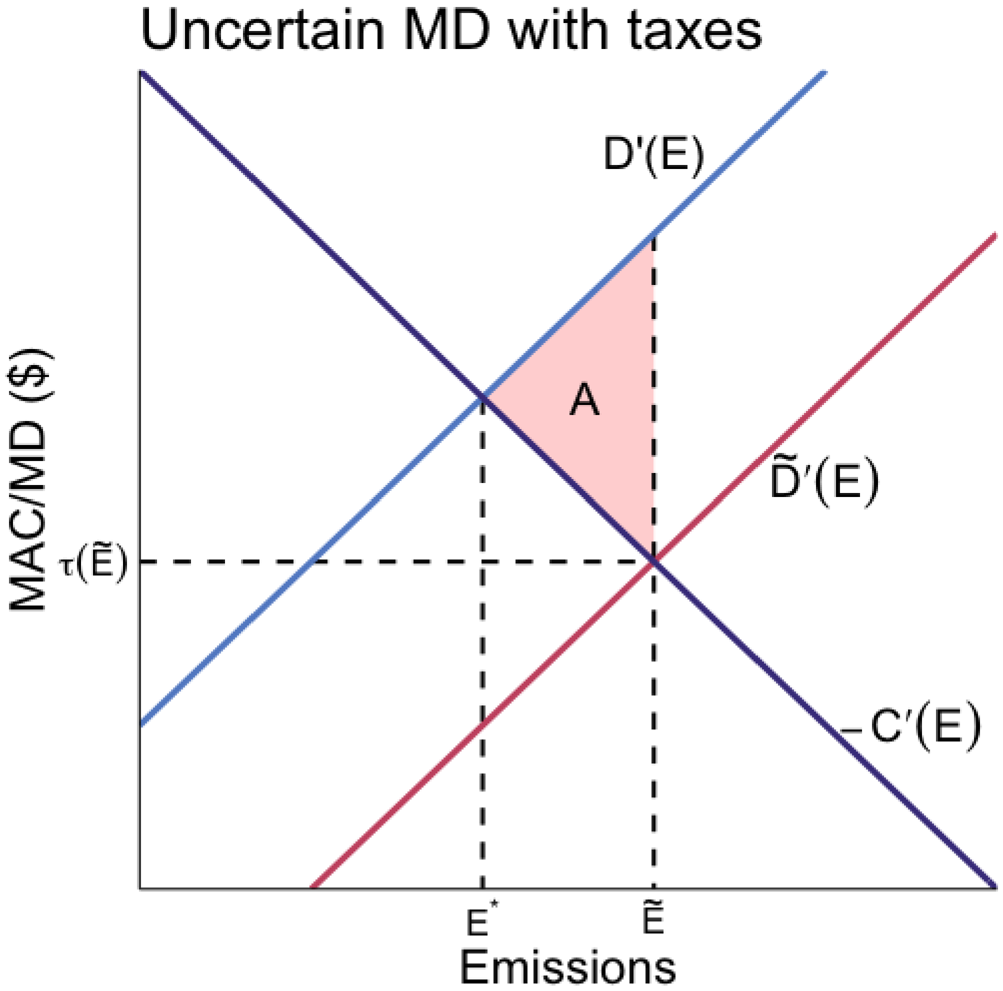
Damage function uncertainty with taxes



Here is the set up

Solve for $\tilde{E}, E^*$ and $E(\tau)$ which is the firm's choice of emissions given τ, and the welfare loss from setting the tax to be $\tau(\tilde{E})$ which achieves $E = \tilde{E}$ given $-\tilde{C}'(E)$

Damage function uncertainty with taxes



The regulator sets the tax as a function of her target emissions $\tau(\tilde{E})$

Since she underestimates D', she sets $\tau(\tilde{E})$ too low

The firm then selects $E(\tau) = \tilde{E}$

She incurs welfare loss A from emissions where marginal damage $>$ marginal abatement cost

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- She sets too low of a tax

Both lead to the exact same welfare loss
so both policies have the same efficiency

Abatement cost function uncertainty

Suppose the regulator estimates $D'(E)$ correctly and underestimates marginal abatement cost: $-\tilde{C}'(E) < -C'(E)\ \forall E$

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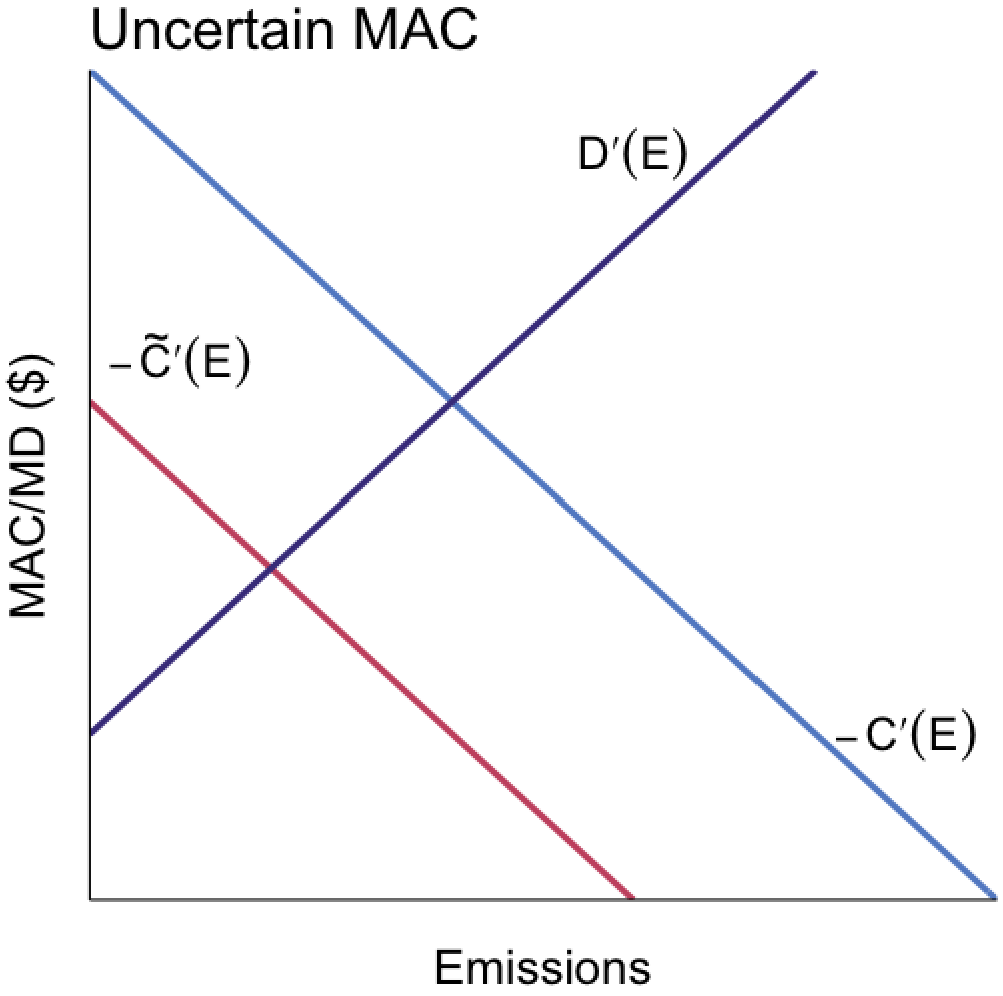

Here's the uncertain MAC problem

Solve for $\tilde{E}, E^*, \sigma(\tilde{E})$, and the welfare loss from setting the number of permits to be $L = \tilde{E}$

Solve for $\tilde{E}, E^*$, and $E(\tau)$ which is the firm's choice of emissions given τ, and the welfare loss from setting the tax to be $\tau(\tilde{E})$

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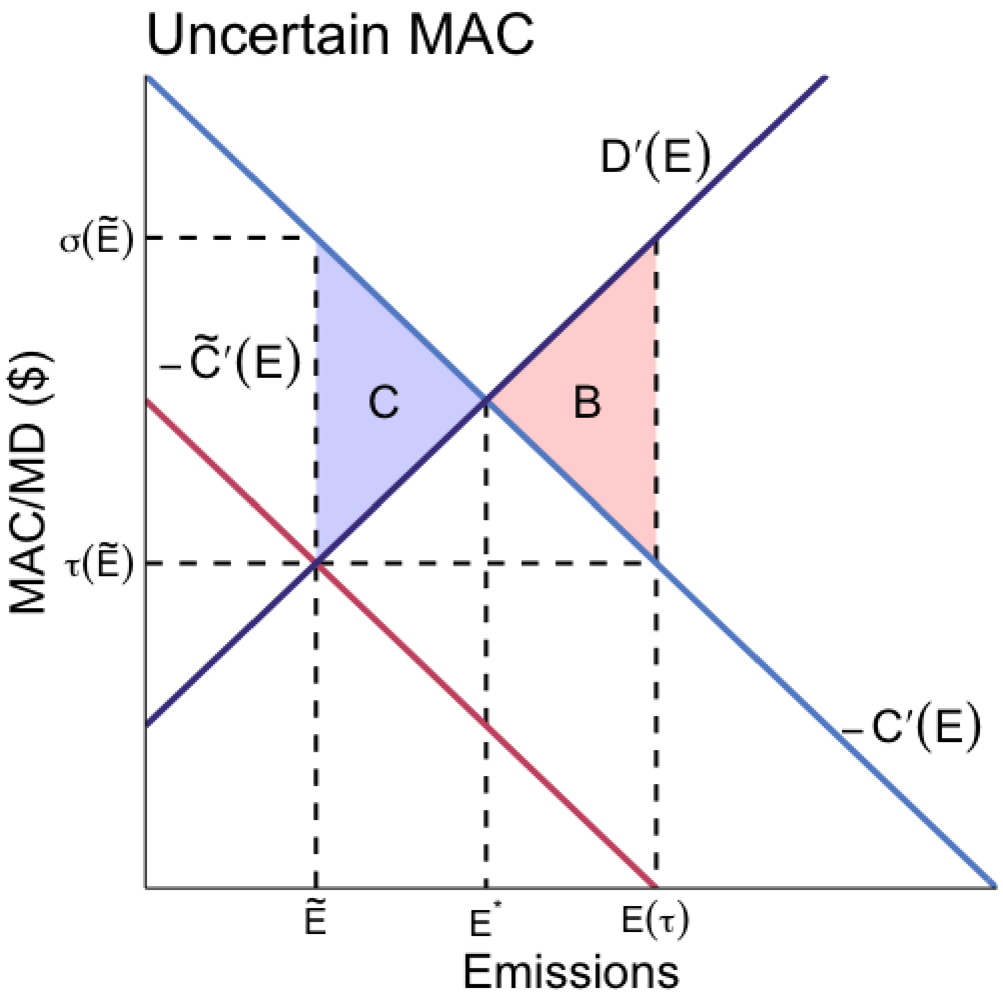
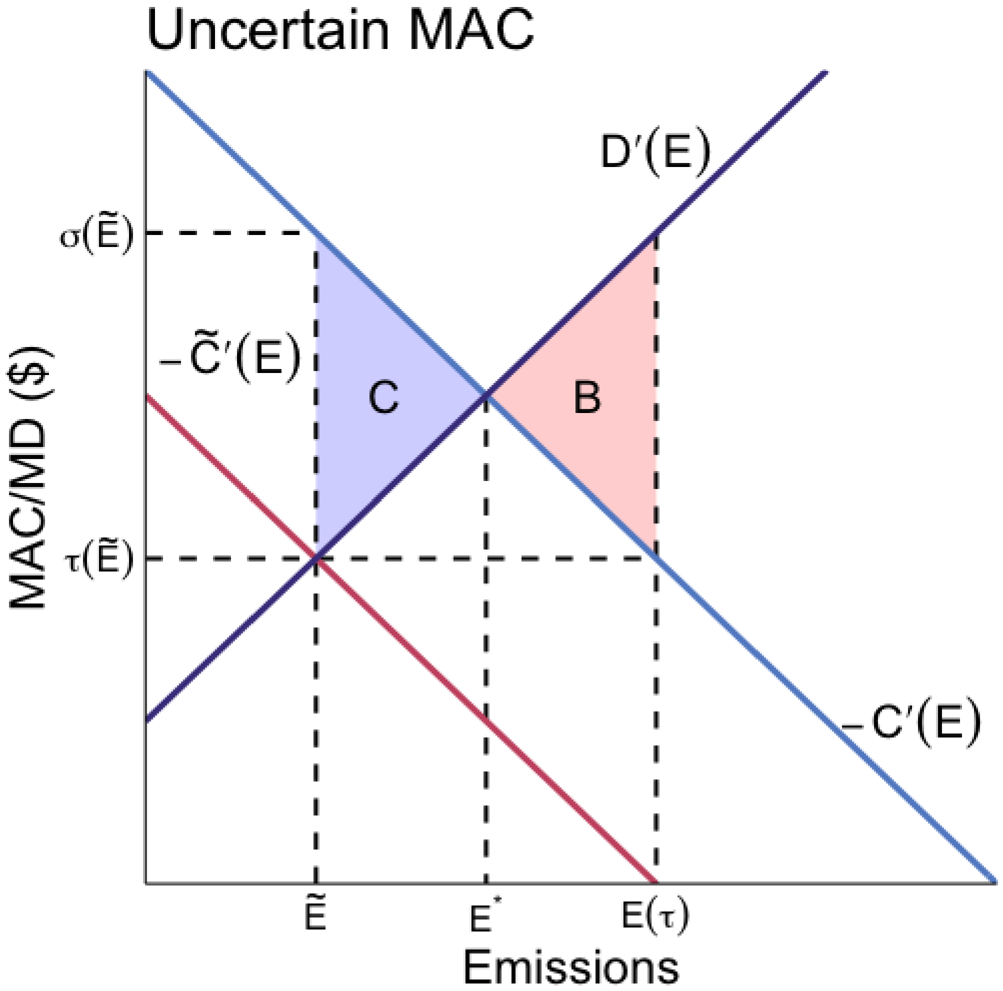


With permits, the regulator allows $\tilde{E}$ permits which results in a permit price of $\sigma(\tilde{E})$ where $\tilde{E}$ intersects the true MAC

This yields a welfare loss of C

Firm behavior sets the price even though quantity is fixed by the regulator

Abatement cost function uncertainty



With a tax, the regulator sets a price $\tau(\tilde{E})$ per unit of emissions, and the firms choose the quantity of emissions where $\tau(\tilde{E}) = -C'(E)$ which causes total emissions to be $E(\tau)$

This yields a welfare loss of B

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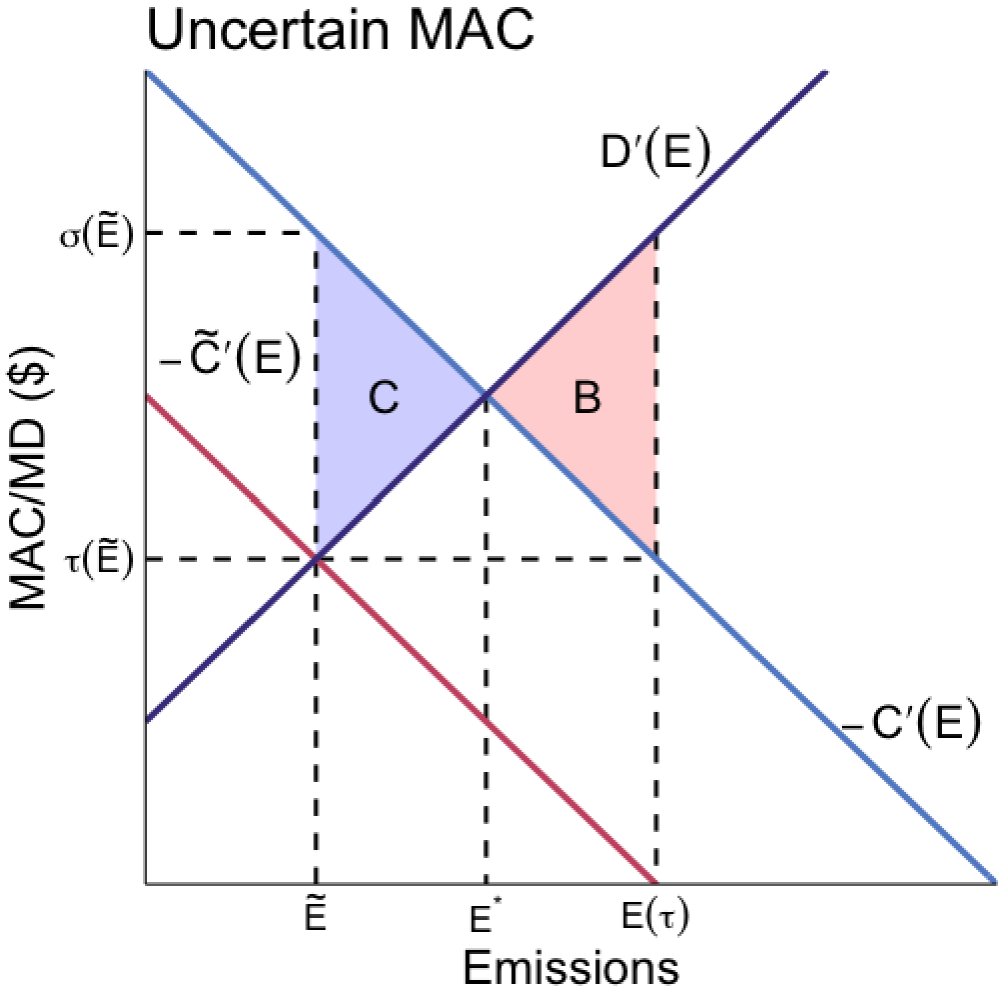
Abatement cost function uncertainty



Since $E(\tau) \neq \tilde{E}$, abatement cost uncertainty matters: tradable permits and taxes give us different emission outcomes

Is there any systematic difference in the efficiency properties of permits and taxes?

Abatement cost function uncertainty

In general it seems like sometimes the welfare loss of taxes will be higher, and other times the welfare losses of permits will be higher

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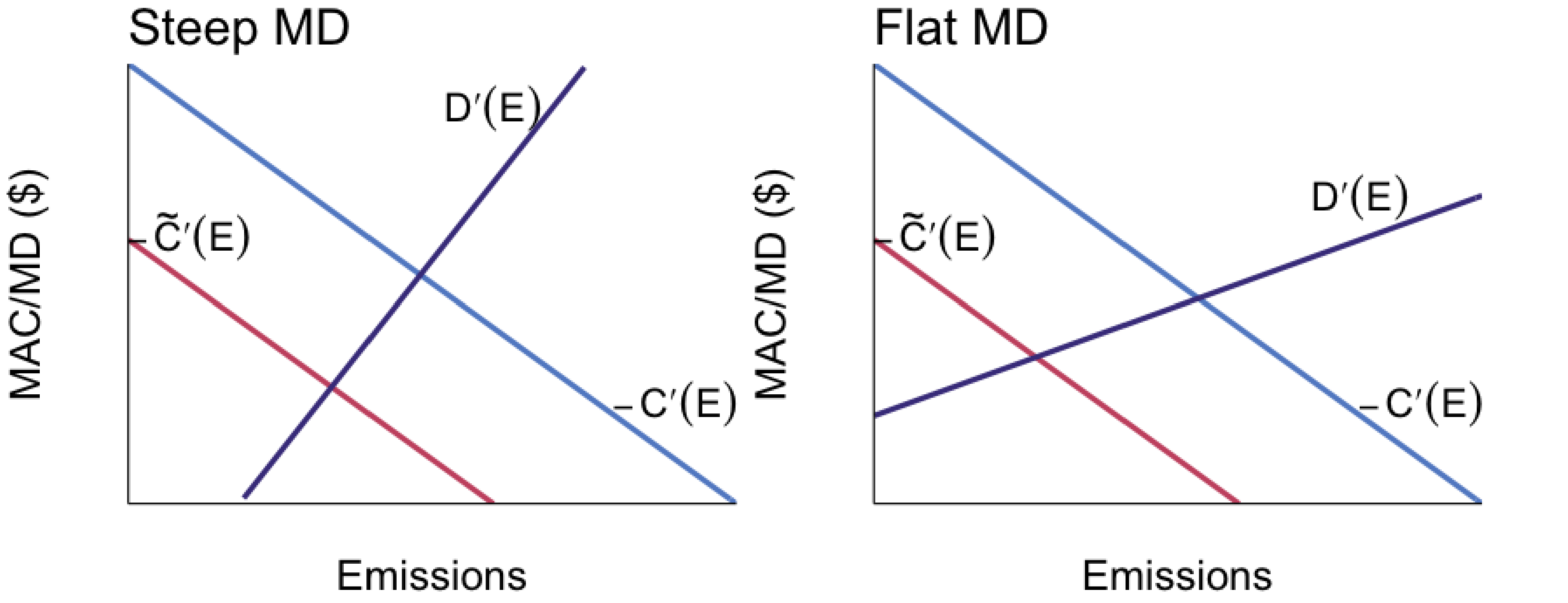
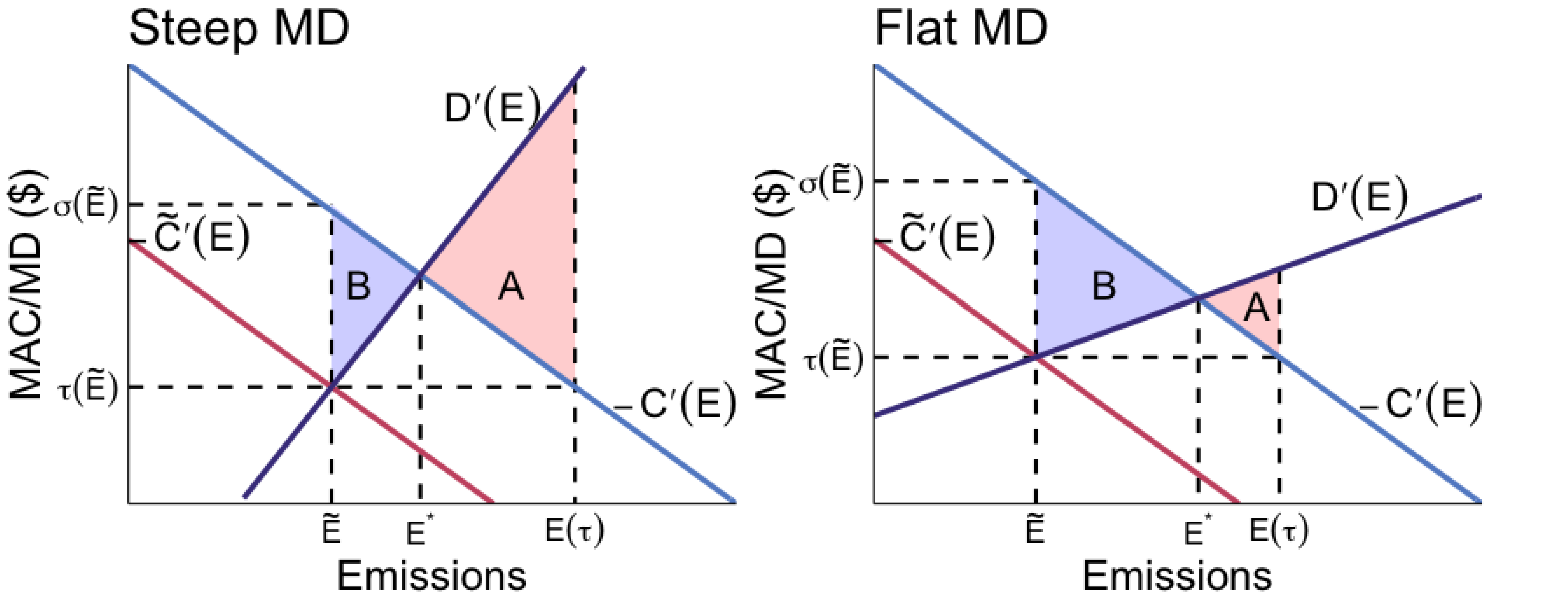
What we will do next is try to understand the characteristics of the MAC and MD curves that tend to drive one policy to be better than the other

Steep versus flat MD



Solve for the permit and tax DWLs in both of these scenarios where the only difference is the steepness of the marginal damage curve

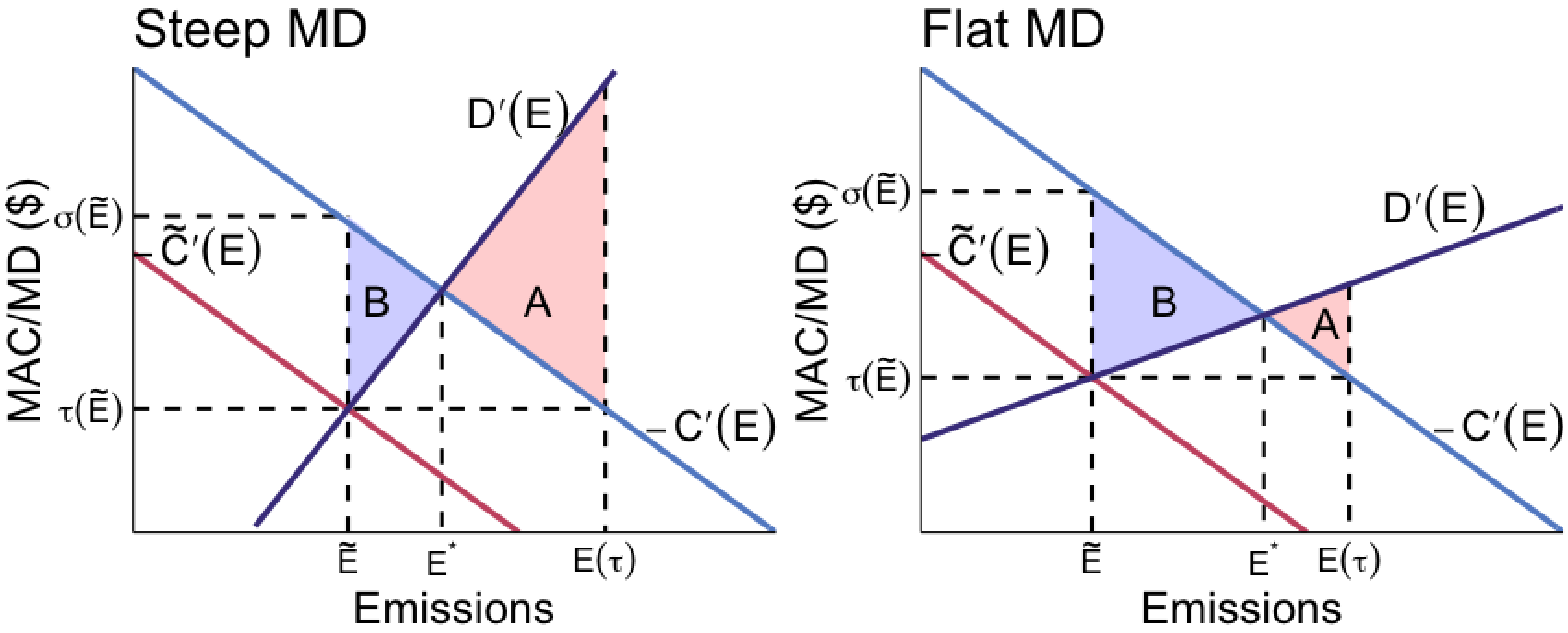
Steep versus flat MD



The only difference between the two plots is how steep the MD is relative to the MAC, and subsequently the policy that the regulator sets

Welfare loss for taxes is given by A, welfare loss for permits is given by B

Steep versus flat MD



Permits do better with steep MD, taxes do better with flat MD!

Why?

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Think about the corner case of a vertical MD

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Flat MD: optimal price of emissions is inelastic with respect to the true MAC

Think about the corner case of constant MD