**ECON 101: Carbon Tax vs. Cap-and-Trade**

The purpose of this page is to describe the differences between a carbon tax and carbon cap-and-trade policies using the most basic of all environmental economic models.

A Model of a Single Polluting Firm

Consider a polluting firm that faces an increasing marginal pollution abatement cost curve. Left unregulated it will choose to abate zero units of carbon and avoid the abatement costs represented by the area underneath the marginal abatement cost curve: B + C + D. Suppose a benefit-cost analysis has determined that optimal abatement occurs at the blue dot where the marginal benefit and marginal cost curves intersect. The resulting level of emissions is e\* (measured right to left along the horizontal axis).

*Carbon Tax*

One way to achieve this level of abatement is to set a tax where marginal benefit equals marginal abatement cost -- represented by the horizontal "tax" line. The polluting firm will notice that it is cheaper to abate carbon emissions as long as the marginal abatement cost is lower than the tax. Since the tax bill (A + B) is greater than the marginal abatement cost bill (B) to the left of the vertical "cap" line the firm will choose to abate. To the right of the "cap" line the marginal abatement cost bill (C + D) is greater than the tax bill (D) so the firm will choose to pay the tax and continue to pollute.

Results:

* The efficient abatement level is achieved: e\*
* The abatement cost to the pollution firm = B + D
* Government revenue = D

*Carbon Cap*

Another way to achieve this level of abatement is to set a cap where marginal benefit equals marginal abatement cost -- represented by the vertical "cap" line. The polluting firm must abate its carbon emissions to e\*.

Results:

* The efficient abatement level is achieved: e\*
* The abatement cost to the pollution firm = B

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A Model with Two Polluting Firms

Now things get a bit more hairy. A two-panel diagram is needed to better understand the logic of trading (click the thumbnail for a bigger image). The two-panel diagram illustrates the increasing marginal abatement costs of two firms. One has an old, dirty, plant with high abatement costs (in blue) that goes right to left with abatement. The other firm has a newer plant that has lower abatement costs (in green) that goes left to right with abatement. The width of the horizontal axis is the abatement that must be achieved to reduce overall emissions to the efficient level.

The intersection of the two marginal abatement costs is where economic efficiency is achieved. This is known as the "equimarginal principle." The total costs of achieving the efficient abatement/emissions level is: C + G + K. The efficient emissions level, e\*, shows that the low abatement cost firm should reduce more emissions than the high abatement cost firm.

*Carbon Tax*

One way to achieve this level of abatement is to set a tax where the marginal abatement costs are equal -- assuming that we have this information (we don't but we can iterate towards the intersection) -- represented by the horizontal "tax" line. As above, the polluting firms will notice that it is cheaper to abate carbon emissions as long as the marginal abatement cost is lower than the tax.

The high cost firm will abate to e\* (right to left) and suffer abatement costs of K and pay a tax bill to the government equal to B + C + F + G. The low cost firm will abate to e\* (left to right) and suffer abatement costs of C + G and pay a tax bill to the government equal to J + K.

Results:

* The efficient abatement level is achieved: e\*
* The abatement cost to the polluting firms, C + G + K, is minimized
* Government revenue = B + C + F + G + J + K

*Carbon Cap-and-Trade*

Another way to achieve this level of abatement is to set a carbon cap by issuing carbon permits to polluting firms. Each permit gives the firm the right to emit one unit of carbon. If we don't have the political will to go ahead and give more permits to the high cost firm (in order to achieve efficiency) we can do it "fairly" by giving each firm the same amount of permits -- represented by the vertical "cap" line. The abatement cost to the low abatement cost firm is equal to area C. The abatement cost to the high abatement cost firm is D + F + G + K.

At some point the high cost firm might rather have a permit than pay those high costs. If it recognizes that its marginal abatement cost is higher than the marginal abatement cost of the low cost firm it could propose a trade. In effect, the blue line over area D, F and G is a demand curve for permits and the green line is a supply curve for permits. Anywhere in between the blue and green line is a permit price that is mutually agreeable between both firms. A competitive permit market will result in a permit price equivalent to the efficient carbon tax. Trading reduces overall abatement costs by area D + F.

Results:

* The efficient abatement level is achieved: e\*
* The abatement cost to the polluting firms, C + G + K, is minimized

Conclusions

In terms of the market failure, the negative carbon externality, both a carbon tax and carbon cap-and-trade will achieve the same level of increased efficiency by achieving the optimal abatement level at the minimum cost. The only difference is the distributional implications. The cost to the firm is lower for carbon cap-and-trade. The government receives tax revenue with a carbon tax. Both policies are preferred over techological or output standards (i.e., command and control regulation).

Note the following extensions:

* Dynamic efficiency: firms have an incentive to adopt new technology to reduce their marginal abatement costs with both a carbon tax and carbon tax-and-trade.
* Double dividend: Carbon taxes and auctioned permits will generate revenue for government that can be used to reduce a budget deficit or reduce in distortionary taxes on labor and/or capital.
* Auctions, giveaways or both: The results of carbon cap-and-trade approach the results for a carbon tax as the extent to which permits are auctioned instead of given away to polluting firms increases. Auctions substitute for trading as high abatement cost firms have an incentive to bid higher.

Source: http://www.env-econ.net/carbon\_tax\_vs\_capandtrade.html