



# Abatement costs

**Ben Glasner**



# Content

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## I. Abatement costs

# Abatement Costs

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- > **Abatement: the ending, reduction, or lessening of something**
- > **We have been dealing with negative externalities for a while now. How do we think about the removal/lessening of a common negative externality like pollution?**
- > **If I am a firm, and I need to cut my pollution, what does that process look like?**

# Abatement Costs

$$MAC_A = 1,050,000 - Carbon^2$$

| Carbon Emissions (Metric Tons) | Marginal Abatement Cost | Total Abatement Cost |
|--------------------------------|-------------------------|----------------------|
| 1000                           | 0                       | 0                    |
| 800                            | \$410,000               | 410,000              |
| 600                            | \$690,000               | 1,100,000            |
| 400                            | \$890,000               | 1,990,000            |
| 200                            | \$1,010,000             | 3,000,000            |
| 0                              | \$1,050,000             | 4,050,000            |

## Abatement Costs

$$MAC_A = 1,050,000 - Carbon^2$$

$$MAC_B = 1,000,000 - (0.9)(Carbon)^2$$

$$MAC_C = 1,300,000 - (1.5)(Carbon)^2$$

| Carbon | $MAC_A$ | $MAC_B$ | $MAC_C$ |
|--------|---------|---------|---------|
| 1000   | 0       | 0       | 0       |
| 800    | 410000  | 424000  | 340000  |
| 600    | 690000  | 676000  | 760000  |
| 400    | 890000  | 856000  | 1060000 |
| 200    | 1010000 | 964000  | 1240000 |
| 0      | 1050000 | 1000000 | 1300000 |

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$$MAC_A = 1,050,000 - Carbon^2$$

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| 400    | 890000  | 856000  | 1060000 |
| 200    | 1010000 | 964000  | 1240000 |
| 0      | 1050000 | 1000000 | 1300000 |

## Let's try another one:

| # of Combustion Engine Vehicles | Amazon |      | UPS |      | FedEx |      |
|---------------------------------|--------|------|-----|------|-------|------|
|                                 | MAC    | TAC  | MAC | TAC  | MAC   | TAC  |
| 800                             | 0      | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40     | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80     | 120  | 160 | 240  | 120   | 180  |
| 500                             | 140    | 260  | 260 | 500  | 200   | 380  |
| 400                             | 200    | 460  | 360 | 860  | 280   | 660  |
| 300                             | 280    | 740  | 480 | 1340 | 400   | 1060 |
| 200                             | 360    | 1100 | 600 | 1940 | 540   | 1600 |
| 100                             | 480    | 1580 | 740 | 2680 | 700   | 2300 |
| 0                               | 600    | 2180 | 880 | 3560 | 860   | 3160 |

If a policy is implemented that forces each firm to transition half of its fleet to electric vehicles, what would be the Total Abatement Cost faced by the firms collectively?

| # of Combustion Engine Vehicles | Amazon |      | UPS |      | FedEx |      |
|---------------------------------|--------|------|-----|------|-------|------|
|                                 | MAC    | TAC  | MAC | TAC  | MAC   | TAC  |
| 800                             | 0      | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40     | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80     | 120  | 160 | 240  | 120   | 180  |
| 500                             | 140    | 260  | 260 | 500  | 200   | 380  |
| 400                             | 200    | 460  | 360 | 860  | 280   | 660  |
| 300                             | 280    | 740  | 480 | 1340 | 400   | 1060 |
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|                                 | MAC    | TAC  | MAC | TAC  | MAC   | TAC  |
| 800                             | 0      | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40     | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80     | 120  | 160 | 240  | 120   | 180  |
| 500                             | 140    | 260  | 260 | 500  | 200   | 380  |
| 400                             | 200    | 460  | 360 | 860  | 280   | 660  |
| 300                             | 280    | 740  | 480 | 1340 | 400   | 1060 |
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| 800                             | 0      | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40     | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80     | 120  | 160 | 240  | 120   | 180  |
| 500                             | 140    | 260  | 260 | 500  | 200   | 380  |
| 400                             | 200    | 460  | 360 | 860  | 280   | 660  |
| 300                             | 280    | 740  | 480 | 1340 | 400   | 1060 |
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**\$300 tax will succeed in reducing the total number of combustion engine vehicles in half. Do you agree? How many vehicles will each firm abate? What is the Total Abatement Cost faced by the firms collectively in this scenario?**

| # of Combustion Engine Vehicles | Amazon |      | UPS |      | FedEx |      |
|---------------------------------|--------|------|-----|------|-------|------|
|                                 | MAC    | TAC  | MAC | TAC  | MAC   | TAC  |
| 800                             | 0      | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40     | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80     | 120  | 160 | 240  | 120   | 180  |
| 500                             | 140    | 260  | 260 | 500  | 200   | 380  |
| 400                             | 200    | 460  | 360 | 860  | 280   | 660  |
| 300                             | 280    | 740  | 480 | 1340 | 400   | 1060 |
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|---------------------------------|------------|------|-----|------|-------|------|
|                                 | MAC        | TAC  | MAC | TAC  | MAC   | TAC  |
|                                 | <b>700</b> |      |     |      |       |      |
| 800                             | 0          | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40         | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80         | 120  | 160 | 240  | 120   | 180  |
| 500                             | 140        | 260  | 260 | 500  | 200   | 380  |
| 400                             | 200        | 460  | 360 | 860  | 280   | 660  |
| 300                             | 280        | 740  | 480 | 1340 | 400   | 1060 |
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|                                 | MAC        | TAC  | MAC | TAC  | MAC   | TAC  |
|                                 | <b>600</b> |      |     |      |       |      |
| <b>800</b>                      | 0          | 0    | 0   | 0    | 0     | 0    |
| <b>700</b>                      | 40         | 40   | 80  | 80   | 60    | 60   |
| <b>600</b>                      | 80         | 120  | 160 | 240  | 120   | 180  |
| <b>500</b>                      | 140        | 260  | 260 | 500  | 200   | 380  |
| <b>400</b>                      | 200        | 460  | 360 | 860  | 280   | 660  |
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|---------------------------------|------------|------|-----|------|-------|------|
|                                 | MAC        | TAC  | MAC | TAC  | MAC   | TAC  |
|                                 | <b>500</b> |      |     |      |       |      |
| <b>800</b>                      | 0          | 0    | 0   | 0    | 0     | 0    |
| <b>700</b>                      | 40         | 40   | 80  | 80   | 60    | 60   |
| <b>600</b>                      | 80         | 120  | 160 | 240  | 120   | 180  |
| <b>500</b>                      | 140        | 260  | 260 | 500  | 200   | 380  |
| <b>400</b>                      | 200        | 460  | 360 | 860  | 280   | 660  |
| <b>300</b>                      | 280        | 740  | 480 | 1340 | 400   | 1060 |
| <b>200</b>                      | 360        | 1100 | 600 | 1940 | 540   | 1600 |
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|                                 | MAC        | TAC  | MAC | TAC  | MAC   | TAC  |
|                                 | <b>400</b> |      |     |      |       |      |
| <b>800</b>                      | 0          | 0    | 0   | 0    | 0     | 0    |
| <b>700</b>                      | 40         | 40   | 80  | 80   | 60    | 60   |
| <b>600</b>                      | 80         | 120  | 160 | 240  | 120   | 180  |
| <b>500</b>                      | 140        | 260  | 260 | 500  | 200   | 380  |
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|                                 | MAC        | TAC  | MAC | TAC  | MAC   | TAC  |
|                                 | <b>300</b> |      |     |      |       |      |
| 800                             | 0          | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40         | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80         | 120  | 160 | 240  | 120   | 180  |
| 500                             | 140        | 260  | 260 | 500  | 200   | 380  |
| 400                             | 200        | 460  | 360 | 860  | 280   | 660  |
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|---------------------------------|------------|-----|-------|
|                                 | MAC        |     |       |
|                                 | <b>200</b> |     |       |
| 800                             | 0          |     |       |
| 700                             | 40         |     |       |
| 600                             | 80         |     |       |
| 500                             | 140        |     |       |
| 400                             | 200        |     |       |
| 300                             | 280        |     |       |
| 200                             | 360        |     |       |
| 100                             | 480        |     |       |
| 0                               | 600        |     |       |

We can see that it costs \$360 to transition from 300 to 200, but it only costs \$300 to keep these 100 vehicles. So it would actually be better for Amazon to pay the tax on these 100 instead of transitioning them.



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|                                 | MAC        | TAC  | MAC | TAC  | MAC   | TAC  |
|                                 | <b>300</b> |      |     |      |       |      |
| <b>800</b>                      | 0          | 0    | 0   | 0    | 0     | 0    |
| <b>700</b>                      | 40         | 40   | 80  | 80   | 60    | 60   |
| <b>600</b>                      | 80         | 120  | 160 | 240  | 120   | 180  |
| <b>500</b>                      | 140        | 260  | 260 | 500  | 200   | 380  |
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|                                 | <b>300</b> |      | <b>500</b> |      |       |      |
| 800                             | 0          | 0    | 0          | 0    | 0     | 0    |
| 700                             | 40         | 40   | 80         | 80   | 60    | 60   |
| 600                             | 80         | 120  | 160        | 240  | 120   | 180  |
| 500                             | 140        | 260  | 260        | 500  | 200   | 380  |
| 400                             | 200        | 460  | 360        | 860  | 280   | 660  |
| 300                             | 280        | 740  | 480        | 1340 | 400   | 1060 |
| 200                             | 360        | 1100 | 600        | 1940 | 540   | 1600 |
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|                                 | <b>300</b> |      | <b>500</b> |      | <b>400</b> |      |
| <b>800</b>                      | 0          | 0    | 0          | 0    | 0          | 0    |
| <b>700</b>                      | 40         | 40   | 80         | 80   | 60         | 60   |
| <b>600</b>                      | 80         | 120  | 160        | 240  | 120        | 180  |
| <b>500</b>                      | 140        | 260  | 260        | 500  | 200        | 380  |
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12 tradeable permits to these companies, each permit allowing for the continued operation of 100 combustion engine vehicles. If the government allocates these permits equitably to the three firms, which firms will be interested in buying more permits and which will be interested in selling?

| # of Combustion Engine Vehicles | Amazon |      | UPS |      | FedEx |      |
|---------------------------------|--------|------|-----|------|-------|------|
|                                 | MAC    | TAC  | MAC | TAC  | MAC   | TAC  |
| 800                             | 0      | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40     | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80     | 120  | 160 | 240  | 120   | 180  |
| 500                             | 140    | 260  | 260 | 500  | 200   | 380  |
| 400                             | 200    | 460  | 360 | 860  | 280   | 660  |
| 300                             | 280    | 740  | 480 | 1340 | 400   | 1060 |
| 200                             | 360    | 1100 | 600 | 1940 | 540   | 1600 |
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|                                 | MAC    | TAC  | MAC | TAC  | MAC   | TAC  |
| 800                             | 0      | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40     | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80     | 120  | 160 | 240  | 120   | 180  |
| 500                             | 140    | 260  | 260 | 500  | 200   | 380  |
| 400                             | 200    | 460  | 360 | 860  | 280   | 660  |
| 300                             | 280    | 740  | 480 | 1340 | 400   | 1060 |
| 200                             | 360    | 1100 | 600 | 1940 | 540   | 1600 |
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| # of Combustion Engine Vehicles | Amazon |   | UPS |      | FedEx |      |
|---------------------------------|--------|---|-----|------|-------|------|
|                                 | MAC    | We can see that it would cost Amazon \$280 dollars to go from 400 vehicles to 300. It also costs UPS \$360 to go from 500 to 400 vehicles. Alternatively, UPS could offer to buy one of Amazon's permits. |     |      |       | TAC  |
| 800                             | 0      |   |     |      |       | 0    |
| 700                             | 40     | 40  | 80  | 80   | 60    | 60   |
| 600                             | 80     | 120   | 160 | 240  | 120   | 180  |
| 500                             | 140    | 260   | 260 | 500  | 200   | 380  |
| 400                             | 200    | 460   | 360 | 860  | 280   | 660  |
| 300                             | 280    | 740   | 480 | 1340 | 400   | 1060 |
| 200                             | 360    | 1100  | 600 | 1940 | 540   | 1600 |
| 100                             | 480    | 1580  | 740 | 2680 | 700   | 2300 |
| 0                               | 600    | 2180  | 880 | 3560 | 860   | 3160 |

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|---------------------------------|--------|------|-----|------|-------|------|
|                                 | MAC    | TAC  | MAC | TAC  | MAC   | TAC  |
| 800                             | 0      | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40     | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80     | 120  | 160 | 240  | 120   | 180  |
| 500                             | 140    | 260  | 260 | 500  | 200   | 380  |
| 400                             | 200    | 460  | 360 | 860  | 280   | 660  |
| 300                             | 280    | 740  | 480 | 1340 | 400   | 1060 |
| 200                             | 360    | 1100 | 600 | 1940 | 540   | 1600 |
| 100                             | 480    | 1580 | 740 | 2680 | 700   | 2300 |
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| 600                             | 80     | 120  | 160 | 240  | 120   | 180  |
| 500                             | 140    | 260  | 260 | 500  | 200   | 380  |
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| 200                             | 360    | 1100 | 600 | 1940 | 540   | 1600 |
| 100                             | 480    | 1580 | 740 | 2680 | 700   | 2300 |
| 0                               | 600    | 2180 | 880 | 3560 | 860   | 3160 |

After UPS buys one of the permits, we can again compare the MAC of the firms and see if anyone would buy/sell.



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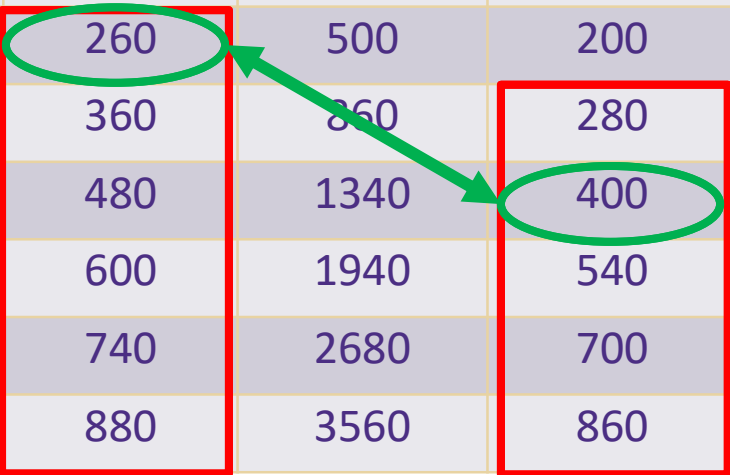
| # of Combustion Engine Vehicles | Amazon |      | UPS |      | FedEx |      |
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|                                 | MAC    |      |     |      | TAC   |      |
| 800                             | 0      | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40     | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80     | 120  | 160 | 240  | 120   | 180  |
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| 200                             | 360    | 1100 | 600 | 1940 | 540   | 1600 |
| 100                             | 480    | 1580 | 740 | 2680 | 700   | 2300 |
| 0                               | 600    | 2180 | 880 | 3560 | 860   | 3160 |

If UPS bought another permit, they would save \$260, This is less than the cost to Amazon if they transitioned from 300 to 200, so they couldn't convince Amazon.

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| 800                             | 0      | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40     | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80     | 120  | 160 | 240  | 120   | 180  |
| 500                             | 140    | 260  | 260 | 500  | 200   | 380  |
| 400                             | 200    | 460  | 360 | 860  | 280   | 660  |
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| 100                             | 480    | 1580 | 740 | 2680 | 700   | 2300 |
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If UPS bought another permit, they would save \$260, This is also less than the MAC to FedEx to move from 400 to 300, so they wouldn't either



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|                                 | MAC    | TAC  | MAC | TAC  | MAC   | TAC  |
| 800                             | 0      | 0    | 0   | 0    | 0     | 0    |
| 700                             | 40     | 40   | 80  | 80   | 60    | 60   |
| 600                             | 80     | 120  | 160 | 240  | 120   | 180  |
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