Economics of Climate Change – Problem Set 4

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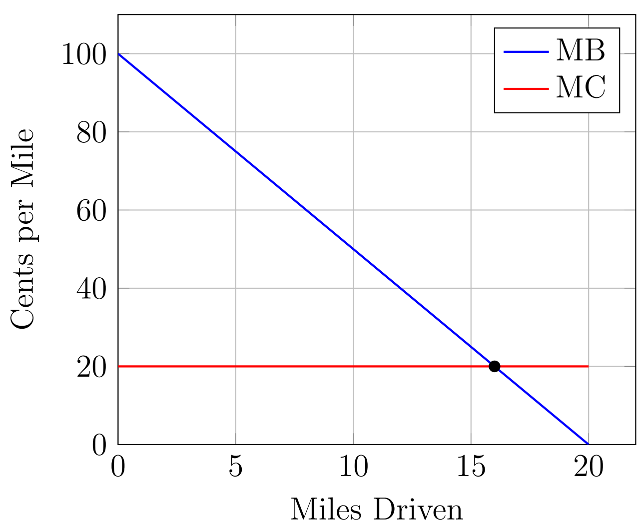
Question 1: Rebound and externalities (70%)

1.1 The marginal benefit and marginal cost are:

$$\mathrm{MB}(x) = 100 - 5x, \quad \mathrm{MC} = 20$$

At equilibrium:

$$100 - 5x = 20 \implies x = \frac{100 - 20}{5} = 16 \text{ miles per year}$$



1.2 The social marginal cost is:

$$\mathrm{SMC}(x) = \mathrm{MC}_0 + \mathrm{MDg}(x) = 20 + 2x$$

The socially optimal quantity of miles:

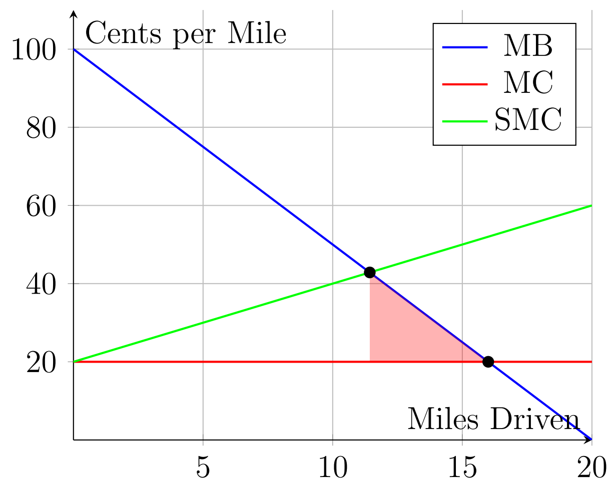
$$\mathrm{MB}(x) = \mathrm{SMC}(x) \implies 100 - 5x = 20 + 2x$$

$$100 - 20 = 7x \implies x = \frac{80}{7} \approx 11.43\,(\text{miles driven each year})$$

The deadweight loss is the area of the triangle between $x_{\text{social}} \approx 11.43$ and $x_{\text{private}} = 16$:

$$\mathrm{DWL} = \frac{1}{2} \cdot (\text{Base}) \cdot (\text{Height}) = \frac{1}{2} \cdot (16 - 11.43) \cdot (2(11.43)) \approx 52.2351$$

Thus, the deadweight loss is 52.2351 cents.



1.3 After switching to an electric Ford F-150, the marginal cost changes to:

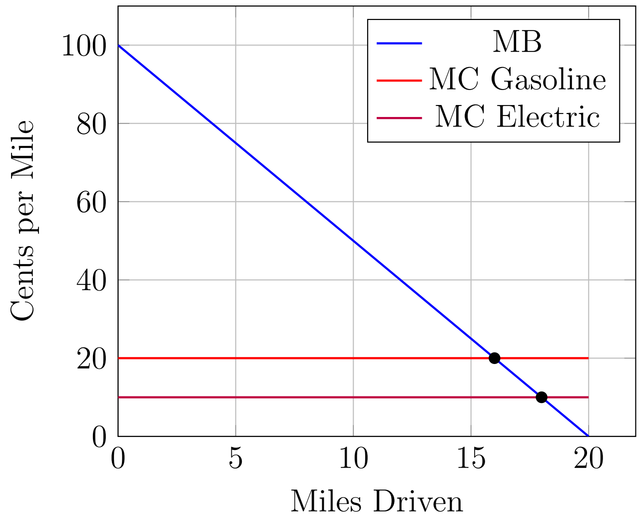
$$\mathrm{MC}_e = 10$$

The equilibrium is found by solving:

$$\mathrm{MB}(x) = \mathrm{MC}_e \implies 100 - 5x = 10$$

$$x = \frac{100 - 10}{5} = 18\,(\text{miles driven each year})$$

The graph below shows the new equilibrium:



1.4 The new marginal damage for the electric Ford F-150 is:

$$\text{MD}_e(x) = 3x$$

The social marginal cost is:

$$\text{SMC}_e(x) = \text{MC}_e + \text{MD}_e(x) = 10 + 3x$$

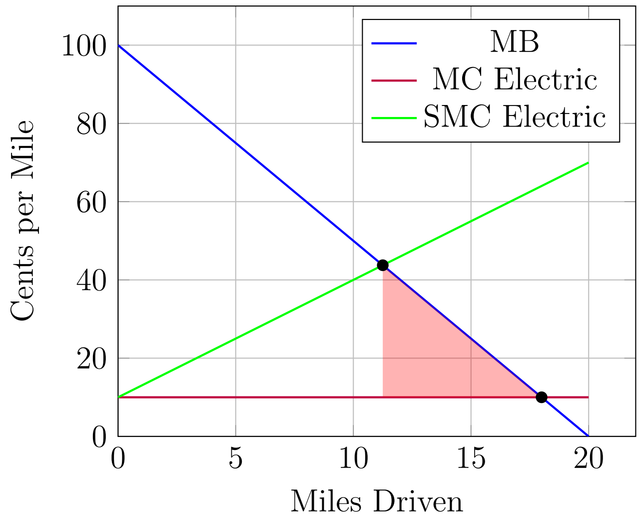
The socially optimal quantity of miles is:

$$\text{MB}(x) = \text{SMC}_e(x) \implies 100 - 5x = 10 + 3x$$

$$100 - 10 = 8x \implies x = \frac{90}{8} = 11.25 \,\text{miles driven each year}$$

The deadweight loss is the area of the triangle between $x_{\text{social}} \approx 11.25$ and $x_{\text{private}} = 18$:

$$\text{DWL} = \frac{1}{2} \cdot (\text{Base}) \cdot (\text{Height}) = \frac{1}{2} \cdot (18 - 11.25) \cdot (3(11.25)) = 113.90625$$



1.5 Electric vehicles offer both benefits and costs in this example:

Benefits:

- Lower marginal cost of driving ($\text{MC}_e = 10$ compared to $\text{MC}_0 = 20$) reduces the direct cost to drivers
- Reduced greenhouse gas emissions compared to gasoline-powered vehicles

Costs:

- Increased vehicle weight due to the battery and drivetrain (6000 pounds heavier) results in higher marginal damage from accidents ($\text{MD}_e(x) = 3x$)
- The reduced marginal cost of driving may lead to a rebound effect, encouraging higher miles driven, which offsets some environmental benefits
- The mix of energy sources for charging (fossil fuels and renewables) means emissions are not eliminated but only reduced

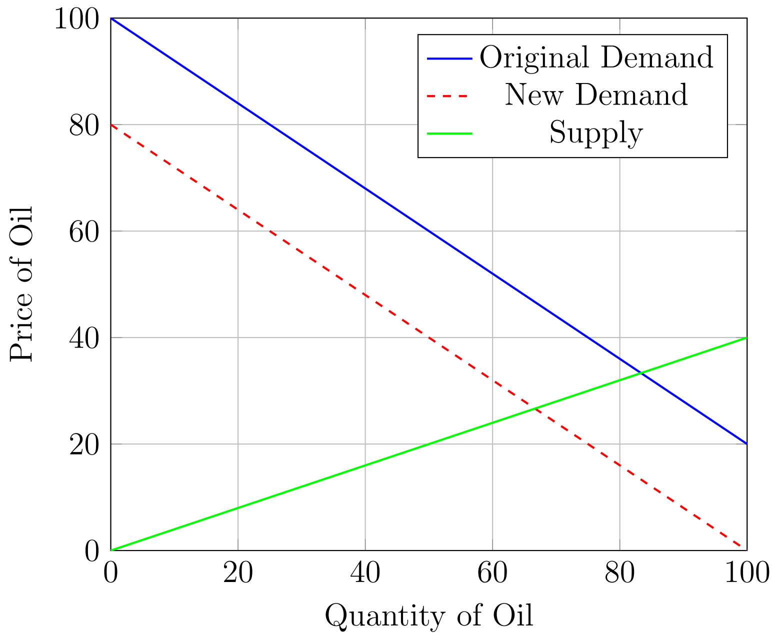
While electric vehicles are a step forward in reducing emissions, careful consideration of externalities like accident risks and energy sourcing is necessary to realize their full potential in addressing environmental and social costs.

1.6 Assume everyone in the U.S. has the same marginal benefits for driving as me, and everyone switches from gasoline to electric vehicles, the effects are:

(a) A significant reduction in gasoline consumption in the U.S. would lead to decreased demand for oil. This would cause a decline in the global price of oil due to oversupply in the market.

(b) Lower global oil prices would make gasoline cheaper in other countries, potentially increasing gasoline consumption and miles driven in these regions. This rebound effect could offset some of the environmental benefits gained from the U.S. transition to electric vehicles.

(c)



Question 2: International Climate Policy (30%)

1. Developed countries argue that climate finance should include contributions from large developing economies like China, citing their growing emissions and economic capabilities. Developing countries emphasize the historical responsibility of industrialized nations for climate change and demand grants instead of loans, ensuring that funds are not reallocated from other aid programs. This links to the concept of a "country-specific social cost of carbon," where developing nations face higher marginal damages from emissions compared to wealthier countries, justifying their demand for greater support.

2. The global community should prioritize a balanced approach between mitigation and adaptation. For example, funding renewable energy projects reduces emissions and supports long-term goals, while building resilient infrastructure protects vulnerable

communities from immediate climate impacts. Both are necessary to achieve sustainable development.

3. The recent election of President Trump has raised concerns about the future of U.S. contributions to climate finance, as Trump has historically opposed climate agreements like the Paris Accord. This creates uncertainty, potentially shifting more responsibility to the European Union and delaying agreements at COP29.