Why Percentage Increase in MPG Fails

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***Percentage increase in MPG*, like linear increase in MPG, is a flawed measure of fuel efficiency. See Section II of the Supporting Online Material (SOM) at Science for a complete analysis of why percentage reasoning ("proportional strategy") fails. This note illustrates the failure of percentage increases with three examples:**

Example 1

A family has two cars. One gets 10 MPG and the other gets 25 MPG. Both are driven roughly the same distance in a year.

Is the family better off replacing the 10 MPG car with one that gets 20 MPG?

Or is the family better of replacing the 25 MPG with one that gets 50 MPG?

Note that both changes describe the same percentage increase: 100% increase in MPG. Alternatively, one can describe it as cutting gas use in half.

The actual gas usage for 100 miles driven for each vehicle is:

10 MPG = 10 gallons per 100 miles
20 MPG = 5 gallons per 100 miles
25 MPG = 4 gallons per 100 miles
50 MPG = 2 gallons per 100 miles.

The family is much better off in terms of gas consumption replacing the 10 MPG vehicle with the car that gets 20 MPG. Doing so saves 5 gallons. The other change, 25 MPG to 50 MPG, saves only 2 gallons over 100 miles. Although both choices represented a 100% increase in MPG, the 10 MPG to 20 MPG increase saved 2.5 times more gas than the 25 MPG to 50 MPG increase.

This example illustrates the reason that percentage improvement in MPG fails: It does not take into account the *starting* amount of gallons consumed per 100 miles at different MPG levels. Put simply, it is more valuable to cut 10 gallons in half than to cut 5 gallons in half. When calculating the benefit of a percentage increase in MPG, one needs to calculate an initial GPM measure to derive the amount of gas saved. Percentage increase *cannot* be compared directly across *different* starting levels of MPG.

Example 2

Improvements from 10 to 11 MPG, 16 to 20 MPG, and 33 to 50 MPG all save roughly the same amount of gas over 100 miles: 1 gallon. You can verify this by dividing 100 by each level of MPG to calculate the total amount of gas used for each MPG level:

10 MPG = 10.00 gallons per 100 miles
11 MPG = 9.10 gallons per 100 miles

16 MPG = 6.25 gallons per 100 miles
20 MPG = 5.00 gallons per 100 miles.

33 MPG = 3.03 gallons per 100 miles
50 MPG = 2.00 gallons per 100 miles.

Note that 10 to 11 MPG is a 10% improvement, 16 to 20 MPG is a 25% improvement, and 33 to 50 MPG is a 50% improvement. Percentage alone would indicate that the change represented by the first pair is least beneficial and the changed represented by the last pair is most beneficial. They are all equally beneficial.

Note that 10 MPG to 13 MPG would be a 30% improvement that saves more than twice as much gas over 100 miles as the 50% improvement from 33 to 50 MPG.

Example 3

The following incremental changes in MPG have been constructed so that each increment is a larger percentage *increase* in MPG but a *decrease* in actual gas saved over 100 miles.

12.5 MPG = 8.00 gallons per 100 miles
20 MPG = 5.00 gallons per 100 miles
35 MPG = 2.86 gallons per 100 miles
70 MPG = 1.43 gallons per 100 miles

12.5 to 20 is a 60% increase in MPG; 20 to 35 is a 75% increase in MPG; and 35 to 70 is a 100% increase in MPG. However each increment in MPG represents a *smaller* savings in the actual amount of gas used per 100 miles: 3 gallons, 2.14 gallons, and 1.53 gallons, respectively.